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A black and white photograph of the Orion spacecraft being launched by a rocket. The spacecraft is oriented vertically, with its nose pointing upwards. The nose cone features the NASA logo and an American flag. The rocket's boosters are visible at the base, with a large plume of smoke and fire at the point of launch. The background shows a dark sky with some clouds and a bright light source, possibly the sun or moon.

2007 Final Report

ESMD Space Grant Faculty Project

2007 ESMD Space Grant Faculty Project

Final Report

from
All NASA Centers

By

Jose J. Granda, Ph.D. (ARC & KSC)
Elmer Grubbs, Ph.D. (JSC & SSC)
Akihiko Kumagai, Ph.D. (GRC & MSFC)
Prabhakar Misra, Ph.D. (LaRC & GSFC)
Nadipuram R. Prasad, Ph.D. (JPL & DFRC)

Lesley Garner, Ph.D.
ESMD Space Grant Faculty Project Manager
NASA Kennedy Space Center

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"In my own view, the important achievement of Apollo was a demonstration that humanity is not forever chained to this planet, and our visions go rather further than that, and our opportunities are unlimited." -- Neil Armstrong, press conference, 1969.

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I. EXECUTIVE SUMMARY

In 2006, the ESMD Space Grant Faculty Project was initiated by the Kennedy Space Center Management Team for the sole purpose of identifying key educational elements that bridge the gap between Space Grant institutions and work performed at NASA Centers. The Faculty Project was performed over a 10-week period during Summer 2007.

The purpose of the ESMD Space Grant Faculty Project is two-fold: 1) to collect Senior Design projects pertaining to Constellation work performed at each NASA Center; and, 2) to identify potential internships for the period of 2007-2008 at each Center relative to Exploration in support of the ESMD Space Grant Student Project.

Senior Design projects are intended to stimulate undergraduate research on current NASA activities related to Lunar, Mars, and other planetary missions, and to bring out innovative and novel ideas that can be used to complement those currently under development at respective NASA Centers. Additionally, such academic involvement would better the prospects for graduating seniors to pursue graduate studies and to seek careers in the Space industry. Internships are intended to provide hands-on experience and training to students on on-going Center activities by engaging students in diverse state-of-the-art technology development, prototype bread-boarding, computer modeling and simulations, hardware and software testing, and a variety of other activities that provide students a strong perspective of NASA's vision and mission in enhancing the knowledge of Earth and Space planetary sciences. Both opportunities are methods to prepare the future space industry workforce.

Five faculty members were competitively selected for this 10 week summer program each working at two NASA field centers. Following are the five paired NASA Centers: Langley Research Center and Goddard Space Flight Center (LaRC-GSFC), Glenn Research Center and Marshall Space Flight Center (GRC-MSFC), Stennis Space Center and Johnson Space Center (SSC-JSC), Ames Research Center and Kennedy Space Center (ARC-KSC), and Jet Propulsion Laboratory and Dryden Flight Research Center (JPL-DFRC).

The outcomes of the ESMD SG Faculty Project are expected to:

1. aid the Centers (both Education Offices and associated technical organizations) in providing relevant opportunities for the ESMD Space Grant Program
2. enable better matches between the ESMD work required and what the Space Grant Consortia can do to effectively contribute to NASA programs
3. provide the Space Grant Consortia an opportunity to strengthen relations with the NASA Centers
4. develop better collective understanding of the Vision for Space Exploration by the Center, Space Grant, faculty, Education Office, and students
5. enable Space Grant institution faculty to better prepare their students to meet current and future NASA needs
6. enable the Center Education Offices to strengthen their ties to their technical organizations and Space Grant Consortia
7. aid Kennedy Space Center in gaining a greater and more detailed understanding of each of the Center activities.

II. SCOPE OF PROJECT (ESMD AREAS)

Four broad areas have been identified that describe the scope of the ESMD Space Grant Educational Projects (Faculty and Student). While there is overlap among the areas, the areas in general capture the essential components for implementing the Vision for Space Exploration. The Project is aimed at collecting Senior Design projects and identifying internships in the following ESMD areas:

Spacecraft: Guidance, navigation and control; Thermal; Electrical; Structures; Software; Avionics; High-speed re-entry; Modeling; Interoperability/commonality; Advanced spacecraft materials; Crew/vehicle health monitoring; Life support systems.

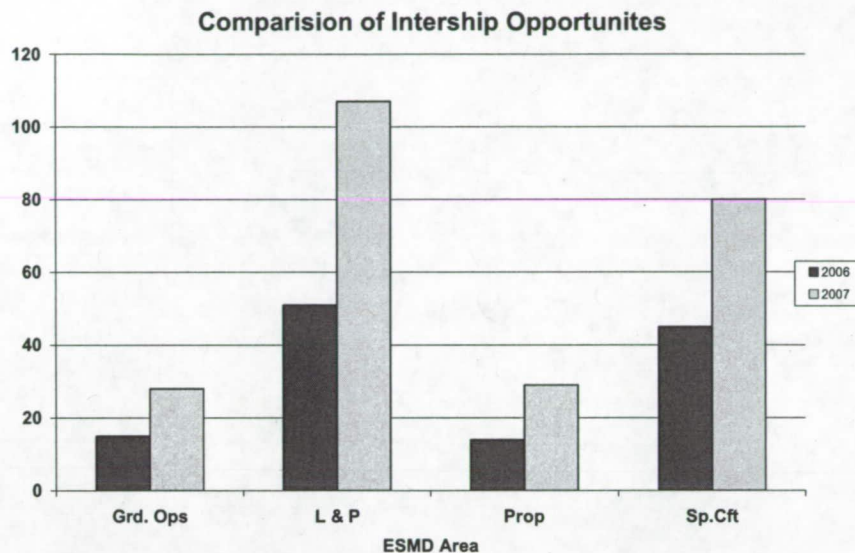
Propulsion: Methods that utilize materials found on the Moon and Mars, "green propellants"; On-orbit propellant storage; motors; testing; fuels; manufacturing; soft landing; throttleable propellants; high performance; and descent.

Lunar and Planetary Surface Systems: Precision landing software; In-situ resource utilization (ISRU); Navigation systems; Extended surface operations; Robotics; Environmental analysis; Radiation protection; Space suits; Life support; Power source and power systems.

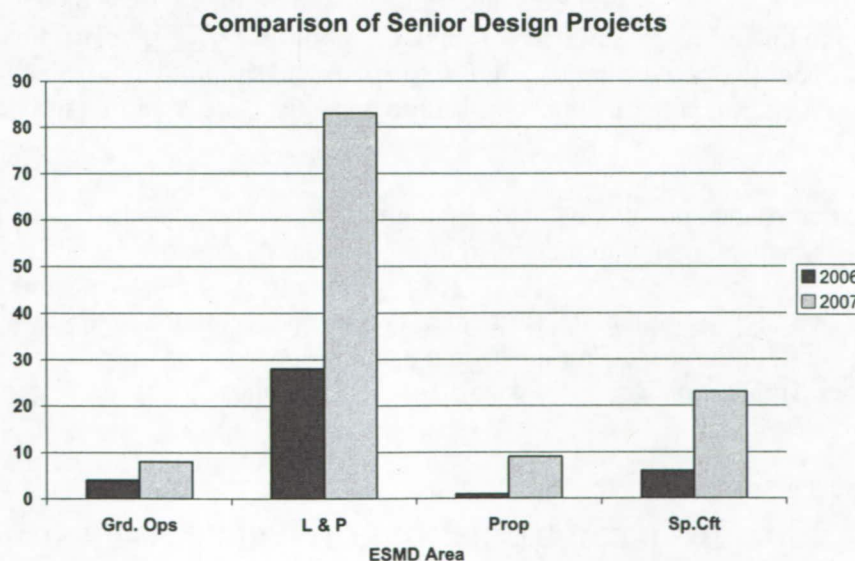
Ground operations: Pre-launch, launch, mission operations; Command and control software systems; Landing and recovery.

Comparison of Center Opportunities

For the 2006-2007 Academic Year there were a total of 125 NASA Center internship opportunities. As of August 10, 2007, the faculty had identified 128 additional internship opportunities for the 2007-2008 Academic Year. This represents a 95% increase over prior statistics. (Please see the ESMD website for current updates).
(<http://education.ksc.nasa.gov/ESMDspacegrant/>)



For the 2006-2007 academic year there were a total of 39 NASA Center senior design opportunities offered. As of August 10, 2007 the faculty had identified 84 additional senior design opportunities for the 2007-2008 academic year. This represents a 115% increase over prior statistics. (Please see the ESMD website for current updates).



III. NASA's EDUCATIONAL STRATEGIC FRAMEWORK

NASA pursues three major education goals:

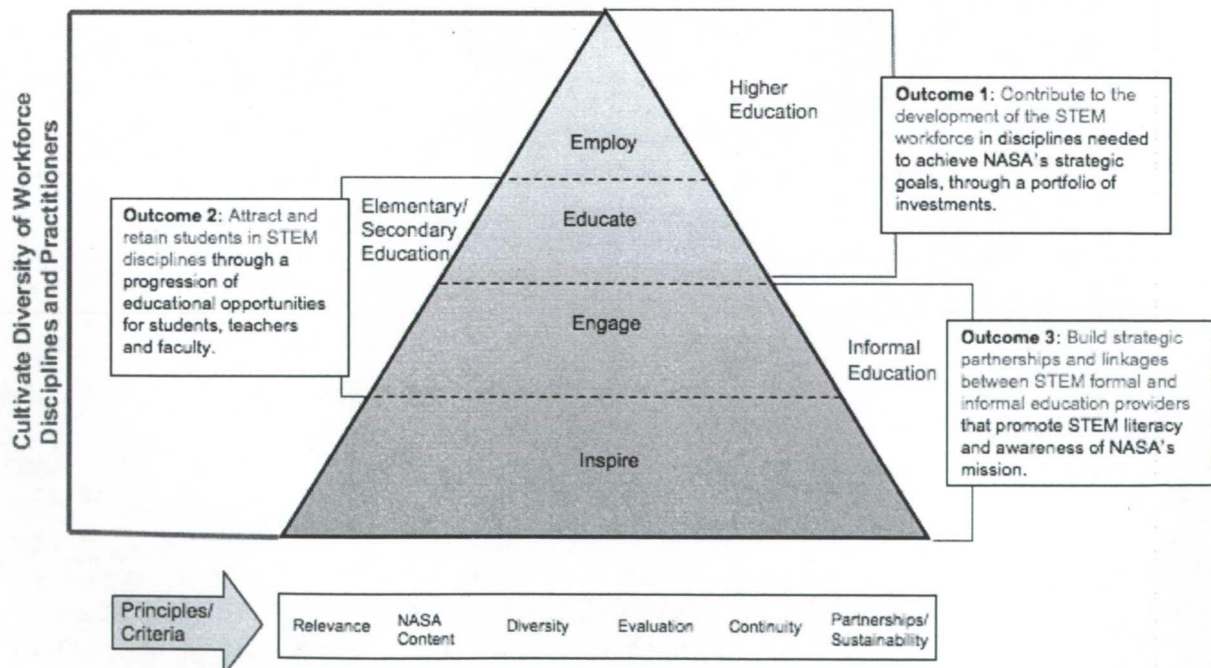
Strengthen NASA and the Nation's future workforce— NASA will identify and develop the critical skills and capabilities needed to achieve the Vision for Space Exploration. To help meet this demand, NASA will continue contributing to the development of the Nation's science, technology, engineering, and mathematics (STEM)

workforce of the future through a diverse portfolio of education initiatives that target America's students at all levels, especially those in traditionally underserved and underrepresented communities.

Attract and retain students in STEM disciplines—To compete effectively for the minds, imaginations, and career ambitions of America's young people, NASA will focus on engaging and retaining students in STEM education programs to encourage their pursuit of educational disciplines critical to NASA's future engineering, scientific, and technical missions.

Engage Americans in NASA's mission—NASA will build strategic partnerships and linkages between STEM formal and informal education providers. Through hands-on, interactive, educational activities, NASA will engage students, educators, families, the general public, and all Agency stakeholders to increase Americans' science and technology literacy.

NASA EDUCATION STRATEGIC FRAMEWORK



Description of the Four Categories of Involvement

Inspire—Activities focused on promoting awareness of NASA’s mission among the public, primarily through informal education and outreach activities. This category is heavily supported by the outreach activities of other NASA organizations, such as the Office of Public Affairs. *Inspire* level efforts are broad, with the goal of reaching a large number of people, but are not limited to “in-person.” This category forms the base of an education structure that becomes more focused at progressively higher levels of the framework “pyramid”.

Engage— Education activities that in some manner incorporate participant interaction with NASA content for the purpose of developing a deeper understanding. Participants are strategically identified and targeted.

Educate—Focused education support that promotes learning among targeted populations. Education activities focus on student learners, or pre- and in-service educators, and are designed to develop and/or enhance specific STEM knowledge and skills using NASA resources. *Educate* activities promote new knowledge acquisition and strengthen an individual’s skills. NASA’s elementary and secondary education efforts are supplementary to formal classroom instruction. NASA’s higher education efforts may include development of specific university curricula in support of the NASA mission and student-built instruments.

Employ—Targeted development of individuals who prepare for employment in disciplines needed to achieve NASA’s mission and strategic goals. Through internships, fellowships, and other professional training, individuals become participants in the Vision for Space Exploration and NASA science and aeronautics research. At the apex, they have acquired sufficient mastery of knowledge for employment with NASA, academia, industry, or within STEM fields of teaching.

In 2006 NASA’s Exploration Systems Mission Directorate (ESMD) partnered with the National Space Grant Consortia (SG) to create the ESMD SG Faculty Project. This Project is aligned with Outcome 1 of the NASA Education Strategic Framework: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA’s strategic goals, through a portfolio of investments.* The Primary Outcome was identified as: *(Employ) Provide NASA competency-building education and research opportunities for faculty, researchers, and post-doctoral fellows.*

IV. CONSTELLATION PROJECT ASSIGNMENTS AT NASA CENTERS

On Monday, June 5, 2006, NASA announced Agency center responsibilities associated with the Constellation Program for robotic and human exploration of the Moon and Mars. The distribution of work across NASA's centers reflects the Agency's intention to productively use personnel, facilities and resources from across the Agency to accomplish the Vision for Space Exploration.

In addition to the primary work assignments each Center will support the Moon and Mars surface systems conceptual designs. Constellation Center assignments are:

Ames Research Center, Moffett Field Calif., leads the crew exploration vehicle (CEV) Thermal Protection System Advanced Development Project. Ames is developing information systems to support the Constellation Program Safety, Reliability, and Quality Assurance Office.

Dryden Flight Research Center, Edwards, Calif., leads CEV Abort Flight Test integration and operations including Abort Test Booster procurement and integration with the Flight Test Article.

Glenn Research Center, Cleveland, leads the CEV Service Module and Spacecraft Adapter integration, providing oversight and independent analysis of the prime contractor's development of these segments. Glenn has lead responsibility for the design and development of several crew launch vehicle (CLV) upper stage systems.

Goddard Space Flight Center, Greenbelt, Md., provides co-leadership of the Constellation Program's System Engineering and Integration navigation team and software and avionics team.

Jet Propulsion Laboratory, Pasadena, Calif., leads a multi-center activity in support of the Mission Operations Project to plan systems engineering processes related to operations development and preparation. JPL provides co-leadership for the Constellation Program Office Systems Engineering and Integration Software and Avionics team.

Johnson Space Center, Houston, host the Constellation Program, the CEV Project and the Mission Operations Project. The Constellation Program manages and integrates the program and all projects. The CEV Project Office manages and integrates all CEV elements including prime contractor work. The Mission Operations Project manages and integrates all activities related to mission operations.

Kennedy Space Center, Fla., hosts the Ground Operations Project. The project manages all activities related to ground operations for the launch and landing sites, including ground processing, launch, and recovery systems.

Langley Research Center, Hampton, Va., leads Launch Abort System integration supporting the CEV Project, providing oversight and independent analysis of the CEV prime contractor's development of the system. Langley leads the Command Module Landing System Advanced Development Project for CEV. Langley provides vehicle integration and CEV test article module development for the CLV Advanced Development Flight Test-0.

Marshall Space Flight Center, Huntsville, Ala., hosts the Constellation Launch Vehicle projects. The projects are responsible for project management of all CLV and cargo launch vehicle related activities. Marshall provides the CLV first stage design, and is responsible for launch vehicle demonstration testing including the Advanced Development Flight Test-0.

Stennis Space Center, Miss., manages and integrates rocket propulsion testing for the CLV Project. Stennis leads sea-level development, certification, and acceptance testing for the upper stage engine, sea-level development testing for the upper stage main propulsion test article, and sea-level acceptance testing for the flight upper stage assembly.

V. FACULTY PROJECT OVERVIEW

Faculty Fellows assigned to the 5 paired NASA Centers were:

Dr. Jose Granda, California State University, Sacramento, CA (ARC & KSC)

Dr. Elmer Grubbs, University of Arizona, Tucson, AZ, (JSC & SSC)

Dr. Akihiko Kumugai, California State University, Sacramento, CA, (GRC & MSFC)

Dr. Prabhakar Misra, Howard University, Washington DC, (LaRC & GSFC)

Dr. Nadipuram Prasad, New Mexico State University, Las Cruces, NM, (JPL & DFRC)

The ESMD SG Faculty Project began on June 4th, 2007, with each faculty reporting to their first assigned Center. Each faculty met with the Center Education Office representative and was appropriately guided to meet with the Center technical staff for discussions pertaining to the ESMD SG Faculty Project. Following completion of the first five weeks, faculty transitioned to the second assigned center on July 9th, 2007. As with the first Center, faculty conducted their investigations at the second Center in a similar fashion. The last week was set aside for final meetings at Kennedy Space Center to finalize the results of the Project and to report on all the key findings.

During each 5-week period faculty made a concerted effort to network with senior technical staff through email and telephone conversations, arrange one-on-one meetings with engineers and scientists, discussed on-going constellation work at the Center, identified possible areas of work that constituted a basis for Senior Design, and identified possibilities for student internships within their respective technical organizations. The meetings also involved visiting laboratories and interacting with researchers and students working side-by-side. This was a unique opportunity for each Faculty Fellow to witness the strengths of such interactions, participate in discussions between students and their mentors, assess the students' and mentors' perception of the value of their internships through an exit survey, and to assimilate the information needed to meet the objectives of the ESMD SG Faculty Project.

The following summaries highlight the individual efforts by each Faculty Fellow towards identifying Senior Design projects and internship possibilities at the five paired NASA Centers. Additional information pertaining to each Center is provided in the Appendices. Detailed information pertaining to Senior Design topics and description, internships, and appropriate Center point-of-contact information is available through Kennedy Space Center Higher Education Office.

Ames Research Center

Professor Jose Granda's began his first 5-week tenure at NASA Ames Research Center, Moffett Field, which is located about 45 miles South of San Francisco, California. Its location is unique as it is in the middle of the Silicon Valley, the heart of the Information Technology industry in the US. It is also surrounded by major aerospace companies such as Lockheed Martin, and by major universities, namely, Stanford, San Jose State, University of Santa Clara, University of California, Santa Cruz, and UC Berkeley. ARC leads the crew exploration vehicle (CEV) Thermal Protection System Advanced Development Project. Ames is developing information systems to support the Constellation Program Safety, Reliability, and Quality Assurance Office.

While at Ames, Professor Granda used two approaches to elicit information from technical staff pertaining to Senior Design projects and internships. The first approach involved making contacts with management refereed technical staff. The second approach involved giving a broad overview presentation to department level management. Management as well as researchers were highly supportive of this approach as it provided a forum for collective discussions regarding the benefits of the ESMD Project. Motivated by the responses a technical presentation was given to the Code TI organization. This brought out most of the student interns working in exploration technology area and others who are funded by programs such as USRP and Robotic Groups particular to Ames. Due to the fact that key players of the ESMD project were the group leaders and researchers working with students, it was decided in coordination with management to make a technical presentation for the entire center and expand the invitation to the other organizations such as Codes R that handles a lot of the engineering work in house.

CODE (T) EXPLORATION TECHNOLOGY MANAGEMENT

At Ames most of the ESMD work passes through the Exploration Directory Code (T) and its organization. This is an important observation that should help the Kennedy Space Center management team to better identify ESMD related work performed within various organizations of Ames.

INTELLIGENT SYSTEMS (CODE TI)

Code TI is where lunar rovers are being developed and tested. One of the researchers within Code TI was instrumental in assisting Professor Granda identify people who are engaged in ESMD related projects, and for setting up presentations by Professor Granda to inform members the purpose of the ESMD Faculty Project. While there are many students within his organization, four students were identified as ESMD interns. This department is a model of student integration with NASA projects.

HUMAN SYSTEMS INTEGRATION (TH)

Code TH is responsible for studying human reactions to stress and fatigue as they relate to space mission exploration. Experiments are being conducted on human subjects with the help of students majoring in Psychology, Mathematics, and Statistics. In this Division researchers are developing systems to monitor the vital signs of Space crew and observe psychological reactions from the Psychophysiology point-of-view. Research is also focused on the psychological reactions of humans and how a team of astronauts can work together on a mission. This group simulates a Mission Control room along with students and researchers performing the job of astronauts. There are internships and Senior Project opportunities in Human-Computer Interaction.

Two broad areas were identified as possibilities for Senior Design in Code TH. 1) Design, development and evaluation of activity planning software tools for human and robotic space and ground operations. These efforts are currently being applied on robotic Mars surface missions as well as in studies to assess the effects of micro-gravity countermeasures on astronauts. Skills required to support this work include computer science, software engineering, and human-computer interaction. 2) Design, development and evaluation of risk and knowledge

management software systems to support safety and quality efforts at NASA, especially for the new Constellation Program, which will be replacing the Space Shuttle Program over the next decade. Skills required to support this work include computer science, software engineering, and human-computer interaction. Other areas in Code TH that also have possibilities for Senior Design include human reaction to screen displays as part of the Human-Computer interaction.

NASA ADVANCED SUPERCOMPUTING (TN)

Ames is home to NASA's supercomputer facility. This is a secured building; management gave Prof. Granda access and was very supportive of what he was doing. There are six groups support the modeling and simulation computation for the entire NASA agency in support of the missions. They support all ESMD and the other four main NASA directorates.

ENGINEERING DIRECTORATE CODE R

The Engineering Directorate Code R at AMES is divided into three major groups. Applied Manufacturing Division (RM), Engineering Systems Division (RE), and Property Management (RF). The Engineering Systems Division is home to the engineering support group at AMES that works as a consulting and engineering staff in house. They perform analysis and build devices in support of other organizations within Ames. This is the applied side of engineering at Ames and student interns work in all engineering fields.

Prof. Granda's experience at Ames was complemented by another simultaneous event in Space exploration. Public Affairs had requested his assistance with the STS-117 mission of the Space Shuttle Atlantis to the International Space Station which was going on at the time. His earlier work in 2005 with JSC engineers in the Guidance and Control Design Analysis Branch of the STS114 mission provided Professor Granda first-hand knowledge of the engineering side of the missions. His task was to explain to the media what was going on with the mission from the engineering point of view. Public Affairs setup interviews with the media for the networks and local media in the US and Latin America. They were broadcast the day before the launch followed by another broadcast the day of the repairs to the thermal blanket of Atlantis mission STS-117 by astronaut Danny Olivas.

Dryden Space Flight Center

Beginning July 9th, 2007, Dr. Prasad was at Dryden Flight Research Center collecting information on Senior Design projects and internship possibilities. His visit was coordinated by Dr. Miriam Rodon and Ms. Cecilia Cordova at the Dryden Education Office.

DFRC is the smallest of all NASA Centers. The Center is currently focused on two broad areas: 1) Abort Flight Tests of the Orion mission to the Moon; and 2) Aeronautics R&D. Again as with the assignment at JPL, the assignment at DFRC was too short to identify with greater specificity all the projects that one would hope for, and yet provided an opportunity to collect significant aspects of Orion flight tests. The flight tests will ensure successful and safe flight to the Moon and return to Earth

Five (5) internships were identified from the Abort Flight Testing (AFT) group. Fourteen (14) Senior Design projects have been identified from the Aeronautics group. The design projects

were identified as part of the constellation work with emphasis on Spacecraft design and Lunar & Planetary Surface Systems areas of ESMD.

AFT is primarily a systems-engineering task that requires sound engineering judgments to ensure crew safety at the time of launch. The launch abort system (LAS) will be tested at the White Sands Missile Range, New Mexico, in September 2008 beginning with Pad-Abort Tests, and successively move up to Ascent-Abort Tests in subsequent years (2009 and 2010). The purpose is to test the performance of the abort systems to protect the Crew Exploration Vehicle (CEV) capsule and to safely eject the capsule to safety. As such, there is no design work involved in this effort. For Summer 2008 and Fall 2008, the lead engineers have indicated the need for five (5) interns who can assist in conducting AFT, and in the data analysis following Pad-Abort Tests.

On July 26th, 2007, Dr. Prasad was requested by Mr. Bowers to present an overview of the Orion Project to 7th and 8th Grade students at the Dryden Flight Research Center. The purpose of this presentation was to inform a group of 20 youngsters the Orion mission to the Moon. These children were part of an elite group of students selected for the Expedition-1 Space Camp offered and directed by DFRC. Discussions highlighted the need to have strong background and knowledge in Science, Engineering, and Mathematics.

On August 4th, 2007, Dr. Prasad was requested to judge the Space Camp competition along with Mr. Al Bowers and a student from University of Cincinnati. The presentation covered student projects of their mission to the Moon and Mars. It was fascinating to see and hear all the wonderful ideas these youngsters had come up with and were bold and confident in their discussions and response to questions. This experience was one more indication of the training and inspiration we need to provide the next generation of engineers and scientists.

Glenn Research Center

Located in the state of Ohio, the birth place of aviation, GRC has been well known as one of the leading research centers for advanced aeronautics and space exploration. For the Constellation Project, GRC is taking leading roles in the areas of space flight systems, avionics, communications, human health care and monitoring, fire detection and suppression, In-Situ Resource Utilization (ISRU), power, and development of small to medium size rocket engines.

The assignment was pursued at the following divisions with the schedule given by the University Affairs Officer at GRC.

<u>Divisions (Code)</u>	<u>Date</u>
Communication Div. (RC)	6/4 – 6/6
Space Process and Experiments Div. (RE)	6/7 – 6/11
Structures and Materials Div. (RX)	6/12 – 6/15
Power and In-Space Propulsion Div. (RP)	6/18 – 6/20
Aero-propulsion Div. (RT)	6/21 – 6/25
Power & Avionics Div. (RT)	6/26 – 6/27
Propulsion, Structures & Thermal Sys. Div. (DE)	6/28 – 6/29
Instrumentation & Controls Div. (RI)	7/2

Detailed arrangements at each division (meetings with possible NASA mentors and office space, etc.) were made through the contact person of the division. Most of the descriptions for ESMD internship and senior design opportunities were generated through the meetings with possible NASA mentors. In some cases, descriptions were provided by mentors. In other cases, descriptions were written by Akihiko Kumagai and they were reviewed and approved by mentors. Some divisions were well prepared for our project. At these divisions, a list of mentors was provided from the division's contact person. All mentors were aware of the objectives of our project before meeting together. There were also divisions which were not well aware of the nature of our project. For these divisions, obviously more work was necessary to explain our assignment and to find mentors who were willing to work with students.

A total of 16 internship opportunities and 6 senior design project opportunities were identified at GRC. Most of these opportunities are in the areas of Lunar and Planetary Surface Systems, and Spacecraft.

At GRC, many research/development activities related with ISRU were observed. In addition to several internship and senior design project opportunities identified, students are encouraged to participate in some new national competitions in this area. One example is Regolith Excavation Challenge which involves the processing of Lunar soil using an autonomous system (<http://www.californiaspaceauthority.org/regolith/>). Many NASA engineers are involved with this competition for creating/reviewing technical rules and judging.

Goddard Space Flight Center

Professor Prabhakar Misra's five-week assignment at NASA GSFC began on July 9, 2007. During this period, Dr. Misra focused on constellation work at GSFC relating to the ESMD primary work assignment, areas of emphasis, potential rotations and competencies which is summarized below.

Primary Work Assignment: GSFC provides co-leadership of the Constellation Program's System Engineering & Integration Navigation team and the Software & Avionics team.

Areas of Emphasis: For Constellation Program Systems Engineering GSFC has responsibility for communications, tracking and support mechanisms for the CEV. These include Flight Performance, Navigation, Software & Avionics, Structures & Loads, and Communication System. In addition, GSFC supports Integration & Test for both the Lunar Reconnaissance Orbiter (LRO) and the Lunar Orbiter Laser Altimeter (LOLA). Other support to LOLA includes IP-based communications, Ground Operations, and Satellite Servicing. Besides the above areas, other GSFC areas of responsibility include the design of a Spacecraft to support a Lunar Mission, evaluation of the current strategy and provision of recommendations for the ESAS mission, and recommendations for instruments on SuitSat 2/3 that are in alignment with Exploration goals and objectives.

Potential Rotations: Lunar Reconnaissance Orbiter Project Office, Mechanical Systems Division, Instrument Systems & Technology Division, Information Systems Division, Mission Engineering & Systems Analysis Division, and the Solar System Exploration Division.

Competencies: Aerospace Engineer, Mechanical Engineer, Systems Engineer, and Electrical Engineer.

The primary networking approach was via telephone and e-mail in order to contact and set up individual appointments and to make presentations at Branch & Division meetings. These meetings and presentations were followed-up with an ESMD flyer and request for project descriptions via e-mail.

The number of potentially new summer internships at GSFC totaled 7, and the number of new Senior Design Projects at the Center is 3. These project opportunities have been summarized in the Appendix.

In the course of conducting the ESMD Faculty Project, Professor Misra was involved in several activities that provided greater depth to the project through knowledge sharing with Center technical staff, and with students and their mentors in both formal and informal settings.

From July 16th - 19th, 2007, Prof. Misra participated in the 10th reunion of the NASA Administrator's Fellowship Program (NAFP) co-hosted by UNSP, NASA HQ and Glenn Research Center, Cleveland, OH. He attended the Constellation Project's picnic/Quarterly Meeting on July 24, 2007, and delivered a PowerPoint presentation to the group about ESMD internship and senior design opportunities for 2008. On July 26, 2007 Dr. Misra visited the Grapple Arm/HST facility and the Robotics Academy with Brian Roberts & his students. Throughout his five-week tenure at GSFC Professor Misra met with ESMD students and mentors and took photographs of students and mentors engaged in ESMD research activities. Towards the end of his tenure at GSFC, he passed out the exit surveys to project mentors and their students to complete, and talked to them in person one-on-one about the pros and cons of the ESMD program at the Center.

Jet Propulsion Laboratory

Beginning June 4th, 2007, Dr. Prasad was at JPL collecting information on Senior Design projects and internship possibilities. His visit was coordinated by Ms. Linda Rodgers at the JPL Education Office.

JPL is a prime NASA subcontractor and is unlike any other NASA Center in that the thrust of the Constellation work is entirely oriented towards robotic missions for planetary exploration. The Center is focused on developing advanced robotic platforms with revolutionary technologies for imaging, guidance navigation and control, landing systems, and with capabilities for scientific exploration of Lunar, Mars, and other planetary systems. The Center is committed to achieving successful robotic missions as a precursor to NASA's manned missions to the Moon, Mars, and beyond. As such, the number of projects that constitute JPL's work is enormous and would take considerably longer periods of time to capture the expanse of projects that JPL scientists and engineers are engaged in. The 5-week assignment was too short to identify with greater specificity all the projects that one would hope for, and yet has provided an opportunity to capture the tip of the iceberg relating to robotics in Space Exploration.

A total of 25 Senior Design projects were collected and 9 possible internships were identified at JPL. Fifteen (15) Senior Design projects and 7 internships were identified from the Lunar

Architecture Team. The team is responsible for developing the necessary planetary infrastructure that can provide a sustainable, expandable, and a reliable framework for very long term operations on the Moon. The remaining 10 projects and 2 internships have been collected from discussions with JPL scientists who are engaged in a broad range of bio-inspired technologies and systems. The design projects and internship possibilities cover a broad range of areas and topics being addressed by teams/individuals within the JPL research and development organization. Appendix I provides a list of Senior Design projects titles identified by JPL mentors.

On July 5th, 2007, Dr. Prasad participated in a videoconference from JPL with 7th and 8th Grade students at the Dryden Flight Research Center. The purpose of this videoconference was to share a broad sense of why robotics is such an important area for Exploration. His discussions highlighted the need to have strong background and knowledge in Science, Engineering, and Mathematics. The students were participants in the FIRST (For Inspiration and Recognition of Science and Technology) robotics competition. A DVD of this 1-hour videoconference was made by JPL Vits services.

Johnson Space Flight Center

The first rotation was at Johnson Space Center (JSC) in Houston Texas. Johnson hosts the Constellation Program as well as the CEV Project and the Mission Operations Project, but for purposes of gathering senior design projects and internships the most important work that they do involves engineering design. The Aerospace and Flight Mechanics Division, Avionics Systems Division, Automation, Robotics, and Simulation Division, Energy Systems Division, Crew and Thermal Systems Division, and Astromaterials Research and Exploration Science Directorate all work on projects which are ESMD related. A five week rotation barely allows one to touch the surface of the immense number of engineering projects at JSC, but is probably sufficient to get ample projects for ESMD without overloading the system with too many projects. The cost involved mentoring projects is something that JSC management is studying very carefully.

The most useful way of obtaining projects at Johnson proved to be contacts provided by the education office. Emails virtually all went unanswered. Phone calls were only partially answered, but if a phone call was proceeded by a call or Email from the education officer, an interview was always granted. Once contacted almost all NASA engineering employees were enthusiastic about the program and about providing projects. They were all extremely busy however and some were not able to provide projects in a timely manner.

A total of 15 senior projects and 18 internships were gathered from JSC for a total of 33 projects altogether. The projects were in many varied areas, mostly in engineering and science. This is an improvement over the 6 projects funded by ESMD at Johnson this year, 4 during the summer and 2 during Fall 2007 semester.

Other events at Johnson included tours of the old and new mission operations facilities, the neutral buoyancy lab and a tour of Martian habitats, which was also where the old centrifuge from the early days of astronaut training was stored. A lecture from the head of the astronaut selection committee was very interesting. The digital learning lab was housed in the education offices and observation of their activities was very enlightening.

Kennedy Space Center

The NASA Kennedy Space Center is located 50 minutes East of Orlando, Florida. It is the biggest of all NASA centers. The center is in a secluded area that includes a natural life refuge. Most of the Center operations happen in the region called the Industrial Region where the headquarters, Operations and Check Out (ONC), and the International Space Station Process facility (ISSPF) are located. There are other buildings in the area of the Vehicle Assembly Building and close to the launch pad of the Space Shuttle. There are other launch sites on the Air Force Base side which are historic places from the Mercury, Gemini and Apollo missions.

Several methods were used to interview researchers and engineers to carry out the Faculty Project. First, Prof. Granda contacted all the researchers Dr. Lesley Garner had identified and set up appointments to discuss the projects. The second method that Prof. Granda used was to go through the internal pages of the KSC center and identify areas of the Center where most scientists and engineers work. The third method was to offer a technical presentation for the entire Center and attract interest in the ESMD Faculty Project.

MOLECULAR MICROBIOLOGY CODE (DYN-3)

This organization is involved in life sciences research in support of Space Exploration activities. The study of water treatment for consumption by the astronauts in Space is a prime research project. Another area of research is the study of metals and metal coatings that produce chemical reactions with the water in storage tanks in the Space shuttle and the Space station.

APPLIED TECHNOLOGY BIOLOGY DIVISION CODE (KT-B-1)

Work conducted in this Division pertains to developing sustainable systems in Space. Research in plant growth under different wavelengths of light, testing of new pharmacological treatment to prevent muscle degradation in microgravitational environments, and animal behavior in various Space environments are being investigated. Students involvement in this research is very much appreciated.

ASRC AEROSPACE CODE (ASRC-19)

This is part of Code KT. (Applied Technology). The focus however is towards developing technologies to support ground operations. This organization is involved in physics, chemistry, cryogenics, electrostatics and the study of lightening. They are also involved in analysis investigation or incidents, sensors, nanotechnology and sensing gases.

APPLIED TECHNOLOGY. APPLIED SCIENCE DIVISION CODE (KT-D-3)

This Division provides Environmental Engineering support for the study of toxic waste in water treatment. Research involves the study of paint coatings and PCB's. The majors desired are chemistry, chemical engineering, and environmental engineering.

Other areas of research include the study of lunar soil, soil particles and the effects on habitats, the study of the dynamics of lunar soil and lunar dust storms. The work is highly mathematical and supported also with a soils laboratory. The students in computer science, mechanical and civil engineering are the most desired majors for this department. There is room for lots of

experiments that can be conducted by students at all levels from undergraduates in the experimental area to PhD's in computer science for the evaluation and writing of software that would implement new mathematical models of dust storms in a vacuum.

APPLIED TECHNOLOGY. APPLICATIONS AND ENGINEERING BRANCHCODE (IT-C1)

This organization focuses on developing visualization software of dynamic and static situations on Earth, on the Moon and on Mars. Visualization techniques use 3-D solid modeling using several software programs to generate videos of planetary surfaces and operations for review by decision makers.

DESIGNING AND DEVELOPMENT ENGINEERING CODE (NE-D)

This Division is involved in the design and development of the egress vehicle that will allow the astronauts to escape in an emergency situation. NASA is to develop these systems in anticipation of the ARES 1 and ARES 5 rockets that will carry the new CEV to the Moon and beyond.

MISSION ANALYSIS BRANCH CODE (VA-H1)

This group is involved in the design, development and operation of the Delta II unmanned rocket. During Dr. Granda's tenure at KSC the Delta II rocket carrying the Phoenix Mars Lander was launched on August 5, 2007. Members of this group are experts in the field of dynamics and control systems. One of the new employees on this team was until recently an intern, which shows how internships and senior projects contribute to the development of the future workforce.

ISS AND SPACEGRAFT PROCESSING DIRECTORATE. CONSTELLATION INTEGRATION DIVISION CODE (UB-E)

They are responsible for the International Space Station Processing Facility operations. Management of this organization is very supportive and uses student interns. The work involves working in a clean room environment in assembling and processing the modules of the space station which will fly on future missions.

During the 5-week tenure at KSC, Prof. Granda met with a large number of top-level management personnel and identified many internship and Senior Design possibilities. His experience from meeting with a diverse group of engineers and scientists was truly enlightening. Concurrent to his assignment, the STS-118 mission took place toward the end of his stay at KSC. Based upon his past involvement with STS-114 and STS-117, Public Affairs invited Prof. Granda to be part of the NASA team that works with the news media during the launch of STS-118 of Space shuttle Endeavour to the International Space Station. Public Affairs setup interviews with Telemundo Network and a major newspaper in Spain for Professor Granda to explain the technical aspects of STS-118 mission. During his participation on this mission, he received the appreciation for this contribution from the Public Affairs office at headquarters.

Langley Research Center

Dr. Prabhakar Misra's five-week summer tenure began at NASA LaRC on June 4, 2007. His primary work assignment was to identify summer internships and senior design projects at LaRC relative to Exploration in support of the ESMD Space Grant Program for the 2008 cycle of competition. To accomplish these tasks he focused on the primary ESMD work assignment for LaRC, areas of emphasis, potential rotations, and applicable competencies. These Center characteristics are summarized below.

Primary Work Assignment: LaRC leads the Launch Abort System integration supporting the CEV Project, providing oversight and independent analysis of the CEV prime contractor's development of the system. In addition, Langley leads the Command Module Landing System Advanced Development Project for CEV. Besides these twin leadership responsibilities, Langley provides vehicle integration and CEV test article module development for the CLV Advanced Development Flight Test.

Areas of Emphasis: LaRC has key roles in Architecture Definition, Launch Abort System, Crew Systems, Flight Dynamics & Control, Entry Descent & Landing, Aerothermodynamics, Structures & Materials, Systems Engineering & Integration, Aeronautics, Aviation Safety, Fundamental Aeronautics Wind Tunnels & Facilities and Space Operations.

Potential Rotations: Integrated Intelligent Flight Deck, Integrated Vehicle Health Management, Integrated Resilient Aircraft Control, Aging Aircraft Mitigation, Supersonics, Subsonics, and Hypersonic Fundamental Aeronautics.

Competencies: Aerosciences, Aerospace Systems Analysis, Aerospace Structural & Material Concepts, Engineering & Safety, and Characterization of all Atmospheres.

The primary approach followed in order to contact potential mentors for ESMD projects was to either call them on the telephone and/or via e-mail to set up appointments spread through each week of the five-week period. Dr. Misra personally met the NASA engineers and scientists, and on occasion students, who were working with them. He was given guided tours of the research laboratories on several such occasions; and he followed-up on these initial meetings with e-mails requesting written descriptions of the potential ESMD projects that would be suitable for summer internships and senior design. In addition, Dr. Misra made PowerPoint presentations at various Branch and Division meetings in an effort to get the message across regarding the availability of ESMD monies for student support to a wider audience of NASA scientists & engineers.

The number of potentially new ten-week ESMD Summer Internship opportunities is 14, and the number of new Senior Design Project opportunities total 6. Details of these opportunities are provided in the Appendix.

Professor Misra took part in the LaRC Tour of the Flight Test Article Development & Integration Branch and the Large Scale Wind Tunnel Facility on June 7, 2007. He participated in a NASA Explorer Schools K-12 Technology Immersion Workshop run by the LaRC Digital Learning Network, June 10-15, 2007, along with 20 teachers, who were provided hands-on training in videoconferencing and digital communication.

Towards the end of his five-week stay at LaRC Professor Misra conducted an exit survey for both the ESMD mentors and the students and gathered photographs of students and mentors involved in various ESMD-related research projects.

Marshall Space Flight Center

MSFC in Huntsville, Alabama is known as the leading NASA center for main propulsion rocket engines. Here in the 1950s, a group of German rocket experts led by Dr. Wernher von Braun and US engineers started developing rockets for our nation's space exploration. The Saturn V rocket for the Apollo project was also developed here. For the Constellation Project, MSFC has the main role for the Ares I and V main propulsion systems and for monitoring/controlling systems associated with these engines. As one of the largest NASA centers, there are also many activities in the areas of materials development/testing, spacecraft hardware, In-Situ Resource Utilization (ISRU), and earth and space science.

On the first day at MSFC, a meeting with people at the University Affairs Office was held to discuss the schedule and plan for the ESMD Summer Project. It was decided that the first week at MSFC would be spent in meetings with division chief level people. The intention of these meetings was to explain the ESMD faculty project and identify possible NASA mentors at each division. An office room for the entire period of stay was provided through the arrangement of the University Affairs Office. This office arrangement was very appropriate in that this was one of only a few buildings where a wireless internet connection for guests was available.

From the responses as a result of the first week meetings with management people, meetings with possible NASA mentors started on the week of July 16. For the last two weeks at MSFC, the University Affairs Office directly called many NASA mentors for making meeting appointments. This accelerated the productivity. For the last two weeks, about 4 to 8 short meetings were held everyday to discuss opportunities for internships and senior design projects. A total of 48 internship opportunities and 14 senior project opportunities were identified. Most of these opportunities are in the areas of Propulsion, Spacecraft, and Lunar and Planetary Surface Systems.

At MSFC, there is an event in which summer interns from all different summer programs present posters from their technical experience at one common place. There were many NASA mentors and staff, and educators/faculty from local schools/institutions participated in this event with interns. This is an excellent way to observe interns' accomplishments and to give some recognition for what they have done.

Stennis Space Center

The second 5 week rotation was at Stennis Space Center (SSC). Stennis is in charge of testing the rocket engines used in space flight. It is the largest rocket test complex in America and is surrounded by a 10 mile radius buffer zone, which means that there is no close available housing for permanent or temporary workers at the space center. SSC also hosts a group which studies weather, climate and other natural science topics related to life on earth, as well as various Naval engineering and training groups.

SSC has 2 directorates and a program office all related to propulsion. The Rocket Propulsion Test program Office only has 8 people in it but usually has 1 or 2 summer interns assigned to it. The Engineering and Science Directorate is the largest potential supplier of internship and senior projects at SSC. Currently neither area has used any senior projects recently, so a "sales program" of some sort needs to be used in the future. This Directorate is housed entirely in 2 buildings on the campus, which are located beside each other, which makes it extremely easy to visit the various science and engineering personnel.

The lead electrical design engineer was chosen to host the ESMD project collector for this rotation and proved to be a very valuable resource. He made introductions in person, which opened the door for Email information and personal follow ups to collect projects for this center. As usual Emails went unanswered most of the time, but visits were easy to make since everyone was in the same building. The only problem was that people were very busy and tended to put off writing up the project descriptions until the last minute. The most projects were gathered from the Electrical, Mechanical and Systems Analysis and Modeling groups, but the Systems Engineering and Integration Division and Science and Technology Division are fertile areas for the future. There were 9 internships and 0 senior projects collected from SSC.

Other activities at this center involved tours of the test stands, including a live demonstration of an actual engine test, as well as a tour of the cave, which is a virtual reality testing room.

Networking within NASA centers

All NASA Centers offer a congenial environment for scientific exchange of information. Such an environment is highly conducive to work performed under this Project. Scientists and engineers responded quickly to inquiries and were very helpful in suggesting contacts in many areas and organizations.

It is particularly important to bear in Mind that The International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR) prohibit dissemination of sensitive information across public channels and media. Restrictions in this regard resulted in generic identification of technology needs described by Senior Design projects.

Project Reporting

All five faculty Fellows participated in weekly telephone conference calls and VITs. Weekly updates on the Project were shared. The faculty utilized the PBMA site to enter current data collected from each Center. Discussions regarding the conduct of the Project were handled by email between all faculty members. Dr. Garner was very helpful and instrumental in providing greater insights into the data gathering process and in streamlining the data into a common reporting format.

VI. EXIT SURVEYS

The exit surveys for interns and mentors were conducted to collect a snapshot of the 2007 ESMD Summer NASA Center internships. The surveys were administrated by each ESMD faculty at his paired NASA centers. All inferences should be made with caution due to the small sample size. The ESMD Student Project Manager is currently collecting data from all mentors and students.

Student interns under the ESMD Program at each Center were asked the following survey questions:

- Q1. The ESMD summer internship met all my expectations.
- Q2. My internship helped to prepare me for my future career.
- Q3. I was satisfied with the guidance provided by my NASA mentor.
- Q4. The program was well organized (schedule, arrangements, etc.).
- Q5. I would recommend the ESMD SG Project to other students.
- Q6. I am more knowledgeable about NASA's ESMD missions and goals because of this opportunity.
- Q7. My internship increased my desires to pursue a career in the space industry.
- Q8. My internship exposed me to novel ideas, techniques, and skills.
- Q9. I experienced real-world applications related to the college coursework I had before beginning this internship.
- Q10. My mentor was available and approachable.

Figure 1 shows the ratings of the above questions based on 33 responses. The rating scores indicate 5 for "Strongly Agree," 4 for "Agree," 3 for "Neutral," 2 for "Disagree," and 1 for "Strongly Disagree." For all questions except Question 4, the rating scores were above 4.0. Overall interns are very satisfied with technical experience and the relationship they developed with their mentors. The rating score of Question 4 (logistics) was 3.33. Many interns commented that they experienced problems with arrangements for housing, computer account, and late notice of acceptance for the internship. The ESMD SG Student Project needs to work with each NASA Center to review these logistic problems to better serve interns in future.

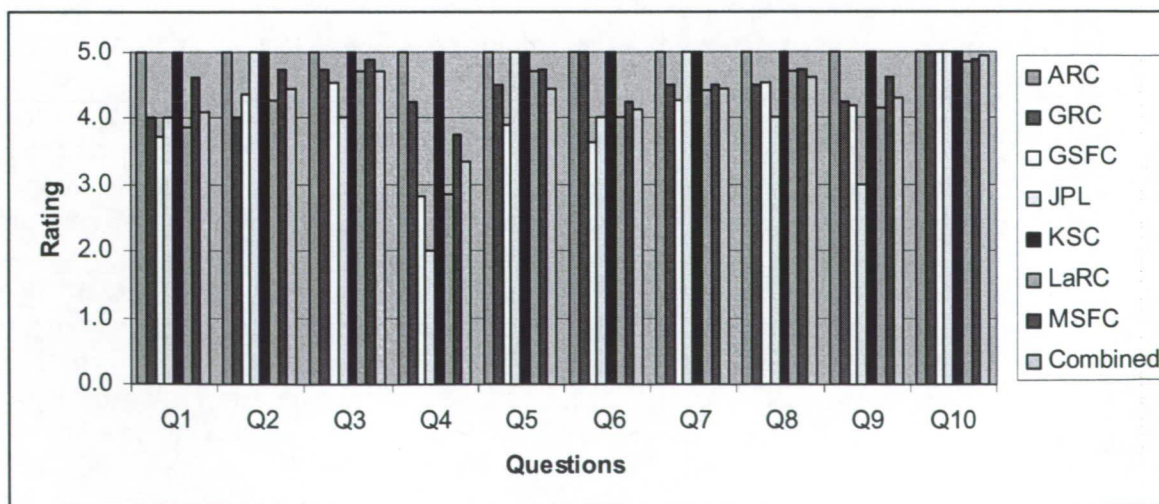


Figure 1: Ratings from the Intern Survey

The survey questions for mentors are as follows:

- Q1. The ESMD summer internship met all my expectations.
- Q2. I am satisfied with the quality of my ESMD intern(s).
- Q3. My intern(s) had appropriate technical knowledge and skills to pursue the assigned work.
- Q4. My intern(s) was (were) available and approachable.
- Q5. The program was well organized (schedule, arrangements, etc.)
- Q6. I would recommend the ESMD SG Project to my colleagues.
- Q7. I would like to work with ESMD interns in the next school year.
- Q8. I am interested in serving as an advisory board member of a senior project.
- Q9. The ESMD SG Project helped evaluating students for possible positions at my NASA center.

Figure 2 shows the ratings of the above questions based on 25 responses. Mentors are very satisfied with the quality of interns in terms of their skills and availability. The intern and the mentor surveys indicate that both students and NASA mentors obtained mutual benefits from the ESMD project. This is a fundamental encouraging factor. However, as it was the case of the intern survey, the rating score of 3.24 for Question 5 reveals that there are logistic issues from the mentors' point-of-view as well. Many mentors complain extra work they had to do, such as providing office space and computers, to help interns get started on their internship. Many logistics issues need to be improved so that mentors and interns will be able to concentrate on their technical tasks.

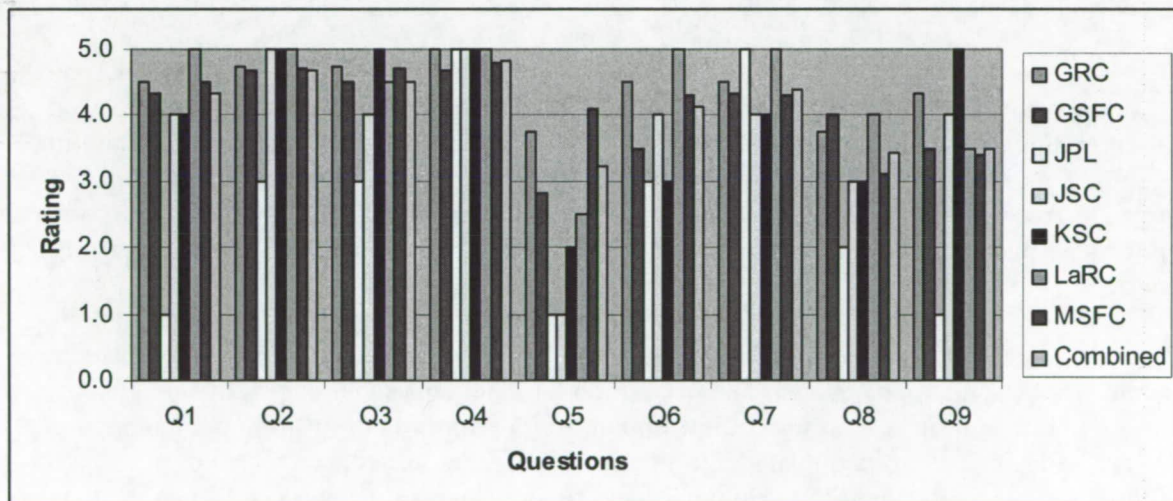


Figure 2: Ratings from the Mentor Survey

VII. LESSONS LEARNED

There are several important lessons that were learned during the conduct of the ESMD Faculty Project. These lessons help identify bottlenecks in the information gathering process and provide the Kennedy Space Center management team a clearer picture of the collective operation of all NASA Centers that will streamline future Faculty Fellowship activities at each Center.

1. Prior to arrival of ESMD faculty at NASA Centers it would be helpful if each Center management was made aware of the purpose and mission of the ESMD Faculty Project. While it is the professional responsibility of faculty to introduce themselves and discuss the objectives to be achieved, prior knowledge within Centers would eliminate any ambiguity concerning the status of the Faculty Fellow and the purpose of their visit. It is important for Centers to realize that Faculty Fellows are not Interns and their selection by NASA is indeed a prestigious position that deserves recognition, and a sense for mutual respect and collaboration towards successful Project outcomes.
2. Sufficient advance notice must be provided to each Center concerning the Faculty visit and to have in place logistics associated with security clearance, badging, office assignment, email ID, and login/password/internet access, etc., so valuable time is not wasted in pursuing the primary objectives of the Project. These issues must be expedited prior to arrival in order to provide ESMD Faculty Fellows a quick means to acclimatize to the Center's constellation activities.
3. Since one of the objectives of the ESMD Project is to bring a greater awareness of Center's knowledge of the internal organizations it is critical that the Education Office take center-stage in bridging the gap between faculty involvements within NASA Centers. The Center Education Office should take an active role in arranging group presentations to senior-level management so the information being sought out by Faculty Fellows is understood to be appropriate, necessary, and meaningful to the outcomes of the ESMD Project. This is tantamount to a top-down system of information dissemination.

Following a top-level management presentation, it would then be the responsibility of the Fellows to arrange meetings with lead-engineer/scientist-level staff for discussions on possible Senior Design projects and/or internship possibilities within their respective organizations. This could facilitate more effective management approval of projects. If management spread the word to their respective organizations and staff about the visit and purpose, then the ESMD faculty would be able to better interact with the staff within the time constraints of the fellowship. In this regard, typically a combination of email and telephone contact would be sufficient to setup appointments and meetings with scientists and engineers.

4. While it is understood that technical staff are busy and have schedules that cannot be undermined, it would be in the interests of the Center Education Office to assist Fellows in their assigned duties and towards achieving favorable outcomes. On occasion it may therefore be necessary for the Center Education representative to facilitate meetings with technical staff so that Faculty Fellows can effectively interact and communicate in a timely manner.

5. Due to the nature of data collected, it is well understood that care must be given towards non-disclosure of sensitive technical information and for the dissemination of such data in the public-domain to conform with ITAR and EAR standards. This will require Faculty Fellows to communicate with the engineers and scientists to mutually agree that the material being reported is acceptable and does not contain restricted or sensitive information.
6. Since there is emphasis on the collection of data pertaining to Exploration it may not always be possible to determine whether or not the Center activities strictly fall within the regime of Exploration. In such instances it is proper to seek guidance from the Center's University Affairs representative about how to achieve the ESMD objectives, and whether or not such objectives can be achieved.
7. The active participation of the Center's Education Office is critical to the success of the ESMD Space Grant Faculty Project. All matters concerning Faculty Fellows' visit to the Center must be handled professionally with the utmost care and dignity with Kennedy Space Center management without jeopardizing the mission of the Project.
8. One of the principal objectives of the ESMD Faculty Project is to enable Space Grant institution faculty to better prepare their students to meet current and future NASA workforce needs. This outcome can come about only by enabling the Center Education Offices to strengthen their ties to their internal technical organizations and Space Grant Consortia.
9. It is not uncommon for a spouse to accompany the Faculty Fellow due to the extended periods of time that a faculty member has to be away from their primary residence. Due to the short duration of the fellowship assignment Center Education Office should assist faculty in locating reasonable housing options. The short duration (5 weeks) at any Center makes it is very difficult to seek housing unless assisted by the Center.

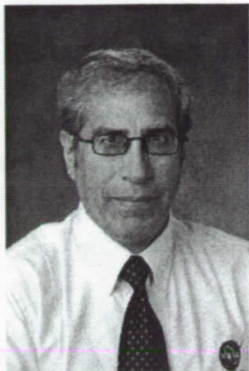
The lessons learned in the summer 2007 ESMD Faculty Project have shown that significant understanding is needed within each NASA Center as to the value and purpose of integrating Space Grant Consortia faculty and students with the NASA workforce. It is believed that effective integration can be achieved through a rigorous program of administering Senior Design projects and through internships at all NASA Centers.

VIII. CONCLUSIONS

1. The ESMD Faculty Project is a truly outstanding effort by the Kennedy Space Center management towards bridging the gap between academia and the NASA vision and mission for Space exploration.
2. It provides students and faculty from all Space Grant universities the opportunity to participate in NASA's exploration activities that integrate all disciplines of Science, Technology, Engineering, and Mathematics.
3. The Project brings better awareness of current NASA research to new faculty who have never been previously associated or exposed to the NASA vision and mission.
4. Better awareness of NASA requirements will enable appropriate shifts in academic curriculum to increase the training and knowledge base of graduating students.
5. The Project provides a compendium of ideas that motivate students and faculty to pursue revolutionary approaches to technology needs for future Space exploration.
6. Exposure to new and novel approaches to Space exploration will better prepare students for future demands for qualified engineers and scientists by the NASA workforce.

IX. FACULTY BIOGRAPHIES

Jose J. Granda



Prof. Jose J. Granda, PhD is a Professor of Mechanical Engineering at the California State University in Sacramento. He obtained his M.S. and Ph.D. degrees in Mechanical Engineering from the University of California, Berkeley and Davis respectively. He is currently Chairman of the Technical Activity Committee on Bond Graph Modeling and Simulation of the Society for Computer Simulation. In 2004, the California State University awarded Prof. Granda the Outstanding Scholarly Achievement Award. The University of California, Davis awarded him the Distinguished Engineering Alumni Award of 2004. Since 2002, Prof. Granda has worked with NASA as a NASA Faculty Fellow, first at the NASA Langley Research Center as part of the Morphing Project and then at NASA Johnson Space Center as part of the engineering team of STS114 mission and the International Space Station.

Elmer Grubbs



Dr. Elmer A. Grubbs is an Associate Professor in the Department of Electrical and Computer Engineering at the University of Arizona. He received his Ph.D. degree in Electrical and Computer Engineering from the University of Arizona in 1994 after receiving the B.S. and M.S. degrees from the University of Arizona and Arizona State University respectively. After receiving the BSEE degree Prof. Grubbs held positions in industry for over 20 years, first at Motorola Semiconductor Division, then at Para-dynamics Corporation, Motorola Government Division, the University of Arizona Medical Center, Hughes Aircraft, Raytheon Missile Systems Division and finally at EOS Technologies. He has also held teaching and chair positions at New Mexico Highlands University and Colorado State University-Pueblo. His research interests are in 3-D Visualization and Natural Language Processing. He has spent three summers working for the Air Force Office of Scientific Research and NASA.

Akihiko Kumagai



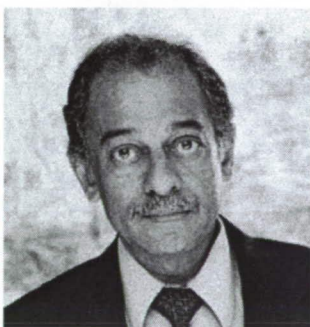
Dr. Akihiko Kumagai is currently an Associate Professor of Mechanical Engineering at California State University, Sacramento (CSUS). He obtained his B.S. in 1983 and M.S. in 1985 from the University of Florida, and Ph.D. in 1993 from University of Wisconsin-Milwaukee all in Mechanical Engineering. He worked for Motorola and United Technologies Automotive as a manufacturing engineer to pursue various Manufacturing and Automation related projects. In Summer 2006, he participated in the NASA Faculty Fellowship Program and worked for kinematics analysis and control simulations of a spaceship docking mechanism simulator at Marshall Space Flight Center. His current teaching and research interests include manufacturing, kinematics, dynamics, robotics, mechatronics and controls. He is a member of ASME and SAE.

Prabhakar Misra



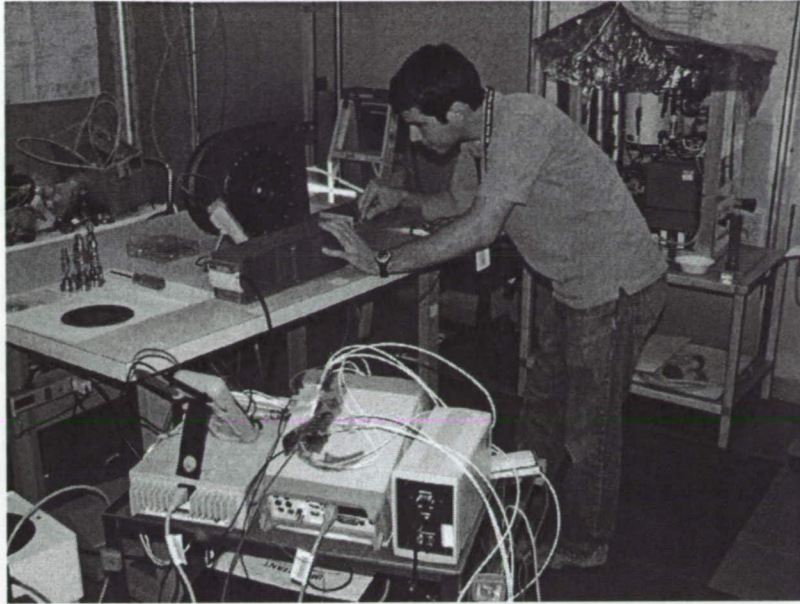
Prabhakar Misra, Ph.D., is a Professor of Physics and Head of the Laser Spectroscopy Laboratory in the Department of Physics & Astronomy at Howard University, Washington, D.C. He earned his M.S. (Physics, 1981) degree from Carnegie Mellon University, Pittsburgh, PA, and his Ph.D. (Physics, 1986) from The Ohio State University, Columbus, OH. In 1999, he received a two-year NASA Administrator's Fellowship Program award: he spent a year (1999-2000) at the Laser & Electro-Optics Branch of the Goddard Space Flight Center, Greenbelt, MD, and the second year (2000-2001) at The National Academy of Sciences in Washington, DC. In 2004, Prof. Misra was awarded the Fulbright Scholar award. He spent the 2004-05 year as a Visiting Professor & Fulbright Scholar in the Department of Chemical Sciences at the Tata Institute of Fundamental Research in Mumbai, India. Dr. Misra's research expertise is in the area of Experimental Laser Spectroscopy of free radicals and stable molecules in a supersonic jet expansion and in a discharge plasma. In 2007, he was selected to be a NASA Exploration Systems Mission Directorate (ESMD) faculty fellow at Langley Research Center and the Goddard Space Flight Center. He is the author or co-author of over 125 research monographs, proceedings, abstracts and refereed journal publications, a technical report for The National Academy of Sciences, and the co-editor of a book titled *UV Spectroscopy and Ultraviolet Lasers* (Marcel Dekker, NY, 2002). He is a member of the American Physical Society, the Optical Society of America, the New York Academy of Sciences, and Sigma Xi, and a Fellow of the American Society for Laser Medicine & Surgery.

Nadipuram R. Prasad



Dr. Nadipuram (Ram) R. Prasad is a tenured full-time Associate Professor in the Klipsch School of Electrical and Computer Engineering Department at New Mexico State University. He earned the S.M degree from MIT in 1971 and worked for several years in the electric power industry. He returned to academia in 1986 earning the M.S and Ph.D in 1988 and 1989, respectively from New Mexico State University. He is the Director of the Rio Grande Institute for Soft Computing (*RioSoft*) at New Mexico State University and *RioRoboLab* a NASA Ames funded Advanced Robotics Laboratory. In August 2001, he was awarded a NASA faculty fellowship under the NASA Administrator's Fellowship Program to spend one year at the NASA/Jet Propulsion Laboratory. During this fellowship Dr. Prasad worked with the Bio-Inspired Technologies and Systems Group where he was involved in several state-of-the-art technology developments for applications within Department of Defense, NASA Earth Sciences, and the US Department of Agriculture. He is a Senior Research Fellow for SPAWAR Systems Center of the Office of Naval Research. Dr. Prasad's research interests are in neural networks, fuzzy logic based systems, and evolutionary computation platforms. Dr. Prasad has authored and co-authored over 150 research publications in journals and conference proceedings, and is the co-author of two books on fuzzy and neural control.

APPENDIX A: PHOTOGRAPHS OF STUDENT INTERNSHIPS



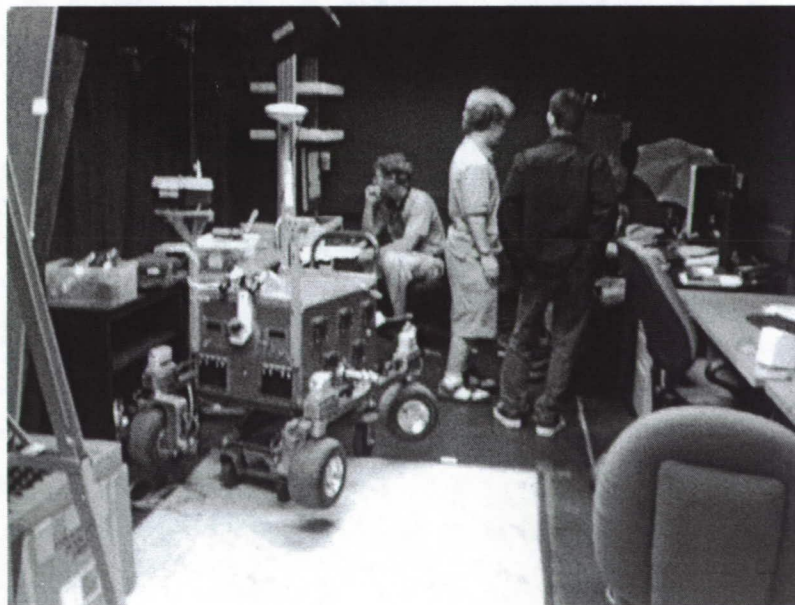
An ESMD intern working on a water recovery system for spacecraft at MSFC



The students are working on a model car, at LaRC which will be used in conjunction with a computer program to develop tracking technology. Tracking technology will eventually allow Unmanned Aerial Vehicles (UAVs, such as the Predator Drone) to refueling mid-flight without human control.



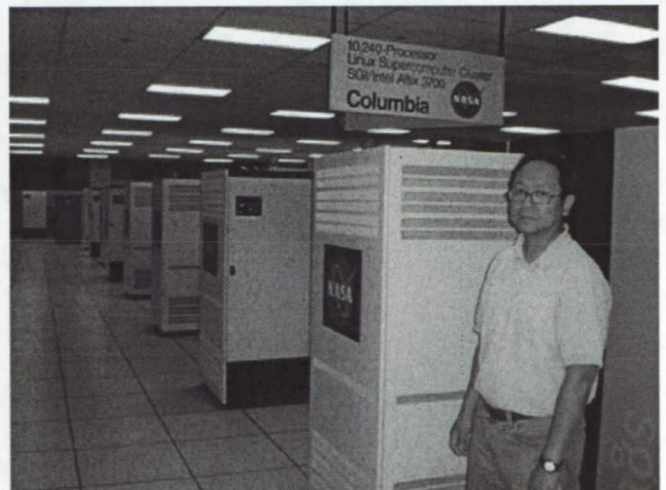
A happy intern at JSC



AMES. Students work on a Lunar Rover from the mechanical aspects to vision and control



AMES.- An ESMD supported student prepares to test a new avionics systems for a Lunar Rover



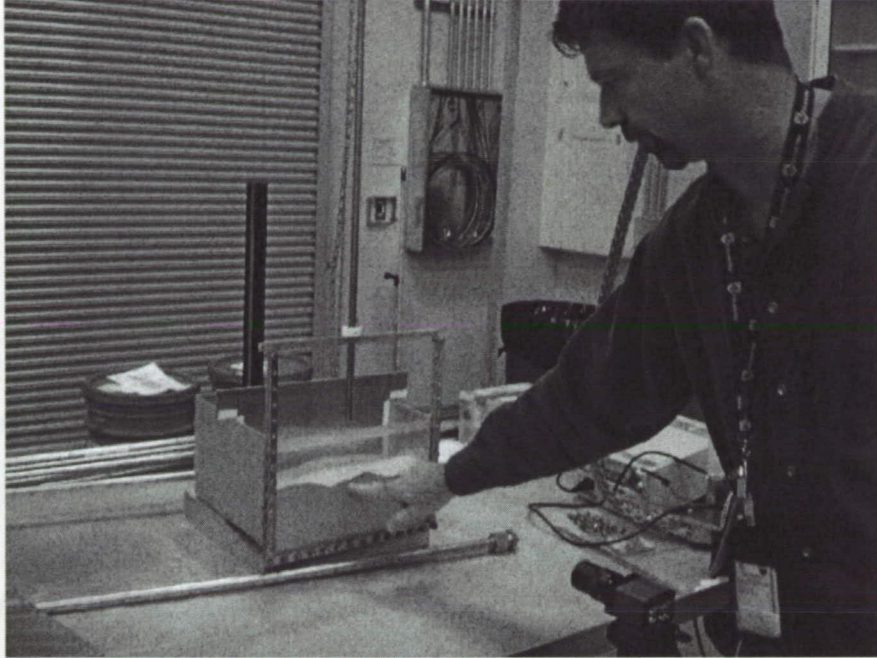
AMES. A researcher in the NAS Numerical Advanced Supercomputing division demonstrates that department participation on the Constellation project and the 10,000 parallel processors COLUMBIA supercomputer facility that supports all NASA centers.



KENNEDY SPACE CENTER. A researcher and a student from the University of Michigan study plant growth under different light spectrum in order to study how to grow plants in space.



KENNEDY SPACE CENTER. A manger on the Space Station Processing Facility shows the assembly of ISS where some students work.



KENNEDY SPACE CENTER. Investigation of the effects of a launch of a vehicle on the Moon are studied with experiments done with fine sand.

Appendix B: Approved Center Internship Opportunities

This was the list on August 10, 2007. Please check the website for the most recent
<http://education.ksc.nasa.gov/ESMDspacegrant/>

Center	Internship #	Area	Description	Time frame
ARC	ARC1-01-08-AN	Lunar & Planetary Surface Systems	3D SURFACE RECONSTRUCTION FROM ORBITAL IMAGERY: Since 1998, the NASA Ames Intelligent Robotics Group (IRG) has been developing stereo vision software to automatically build high-quality 3D surface models from orbital images in a matter of hours (with minimal or no human intervention). The goal of this project is to adapt this software for use with the Mars Reconnaissance Orbiter, historic Apollo camera images, and cameras planned for the Lunar Reconnaissance Orbiter. This project involves software development in C/C++, focused on applied computer vision and 3D modeling.	Fall/Spring/Summer
ARC	ARC1-02-08-AN	Lunar & Planetary Surface Systems	COMPONENT BASED ARCHITECTURE FOR PLANETARY ROVERS: The NASA Ames Intelligent Robotics Group (IRG) operates mobile robots using a rich library of robot software. IRG is currently developing a new component-based architecture to speed the development of new high-level robot controllers and make it easier to integrate new components (such as a new sensor). This project involves developing new robot software systems and requires strong knowledge/experience in C/C++ and distributed systems.	Fall/Spring/Summer
ARC	ARC1-03-08-AN	Lunar & Planetary Surface Systems	ENHANCED AUTONOMOUS VISUAL SAMPLING: The NASA Ames Intelligent Robotics Group (IRG) uses computer vision to autonomously position scientific instruments (e.g., a microscopic imager on a robot arm). This project will improve this process in one (or more) ways: autonomously detect scientifically interesting microstructure and prioritize data, 3D modeling using depth from focus, build 2D/3D image mosaics, and use visual servoing to control robot arm movement. This project involves computer vision theory, software development, and robot experiments.	Fall/Spring/Summer
ARC	ARC1-04-08-AN	Lunar & Planetary Surface Systems	HUMAN-ROBOT SITE SURVEY: This objective of this project is to develop an effective system for performing surface surveys of lunar sites. In particular, we will develop: (1) techniques for multi-robot teams to perform site survey using methods similar to ones used by civil engineers on Earth and (2) human-robot interaction to improve survey performance and effectiveness. Tests will be performed in the NASA Ames "Marscape" outdoor test site as well as in analog	Fall/Spring/Summer

Center	Internship #	Area	Description	Time frame
			field environments such as Meteor Crater (Arizona), Mauna Kea (Hawaii) and Haughton Crater (Canadian Arctic). This project involves software development in C/C++ (embedded, robot navigation, and interactive 3D graphics).	
ARC	ARC1-05-08-AN	Lunar & Planetary Surface Systems	NON-PREHENSILE MOBILE MANIPULATION: The goal of this project is to design non-prehensile robot manipulation devices for lunar surface operations, such as digging/trenching, loading, cable running, conveying, or dumping. A variety of approaches are possible including pushing, tapping, or rolling a part. Non-prehensile systems should take advantage of different strategies for manipulation, such as picking up a part by pushing it against a fixed obstacle. This project involves electrical and mechanical engineering and some embedded system (e.g., microcontroller) programming.	Fall/Spring/Summer
ARC	ARC1-06-08-AN	Lunar & Planetary Surface Systems	REAL-TIME STEREO VISION FOR ROBOT NAVIGATION: Computer vision systems are used extensively within the NASA Ames Intelligent Robotics Group (IRG) to perform a myriad of robotics functions. The goal of this project is to take advantage of hardware-based stereo vision (GPU and FPGA acceleration) to enable very fast obstacle avoidance, navigation, and terrain modeling. This project involves computer vision theory, cross-platform software development (Linux and C++), and mobile robot testing.	Fall/Spring/Summer
ARC	ARC1-07-08-AN	Lunar & Planetary Surface Systems	USER INTERFACES FOR CONTROLLING MULTIPLE COOPERATING ROBOTS: VizExplorer is an interactive 3D user interface developed by the NASA Ames Intelligent Robotics Group (IRG) as a tool for immersive visualization of remote environments. It allows mission operations teams to study data collected by robot explorers and to assemble robot command sequences. Some possible ideas for improving VizExplorer include: adding command sequencing tools for multiple robots, incorporating speech and dialogue, adding predictive graphics (for time-delayed teleoperation). This project involves software development of multi-threaded Java applications, user interface design, and an understanding of 3D graphics.	Fall/Spring/Summer
ARC	ARC2-08-08-AN	Ground Operations	High-fidelity aerospace modeling and simulation , including aerodynamics, aerothermodynamics, aeroelasticity, combustion, missions, risk analysis, etc. Internship: Perform established modeling and simulation (M&S) task or study one advanced M&S approach	Fall/Spring/Summer
ARC	ARC2-09-08-AN	Ground Operations	Advanced gridding techniques for aerospace systems, including multi-zone grid tools, automated gridding, automated mesh refinement, multi-body gridding techniques, etc.	Fall/Spring/Summer

Center	Internship #	Area	Description	Time frame
ARC	ARC2-10-08-AN	Ground Operations	Supercomputer system benchmarking, performance analysis, and comparative analysis.	Fall/Spring/Summer
ARC	ARC2-11-08-AN	Ground Operations	Advanced supercomputing architecture R&D, for improved price-performance and/or programmability for NASA applications.	Fall/Spring/Summer
ARC	ARC2-12-08-AN	Ground Operations	Supercomputer application development programming paradigms and tools that significantly reduce the effort and technical challenge of converting a mathematical model or serial application code into a correct and efficient supercomputer app code. Internship: Study one advanced app dev programming paradigm by implementing it in a known benchmark (such as one of the NAS Parallel Benchmarks), or conduct a user study/survey to identify useful functionalities for parallel programming tools.	Fall/Spring/Summer
ARC	ARC2-13-08-AN	Ground Operations	Supercomputer user environments with more intuitive, intelligent, and integrated interfaces to supercomputing resources, services, and simulation data.	Fall/Spring/Summer
ARC	ARC2-14-08-AN	Ground Operations	Advanced data analysis and visualization techniques for large-scale simulation data, hyper-dimensional data, real-time simulation data streams, and hyperwall environments.	Fall/Spring/Summer
ARC	ARC1-15-08-AN	Lunar & Planetary Surface Systems	1. Design, development and evaluation of activity planning software tools for human and robotic space and ground operations. These efforts are currently being applied on robotic Mars surface missions as well as in studies to assess the effects of micro-gravity countermeasures on astronauts. Skills required to support this work include computer science, software engineering, and human-computer interaction	Fall/Spring/Summer
ARC	ARC1-16-08-AN	Lunar & Planetary Surface Systems	Design, development and evaluation of risk and knowledge management software systems to support safety and quality efforts at NASA, especially for the new Constellation Program which will be replacing the Space Shuttle Program over the next decade? Skills required to support this work include computer science, software engineering, and human-computer interaction.?	Fall/Spring/Summer
ARC	ARC1-17-08-AN	Lunar & Planetary Surface Systems	Intelligent Robotics Group (IRG) has been developing stereo vision software to automatically build high-quality 3D surface models from orbital images in a matter of hours (with minimal or no human intervention). The goal of this project is to adapt this software for use with the Mars Reconnaissance Orbiter, historic Apollo camera images, and cameras planned for the Lunar Reconnaissance Orbiter. This project involves software development in C/C++, focused on applied computer vision and 3D modeling.	Fall/Spring/Summer
ARC	ARC1-18-08-AN	Lunar & Planetary Surface	SITE OPERATIONS SUPPORT: The focus of this project is to develop "utility" mobile robots and procedures to automate lunar site operations. Site	Fall/Spring/Summer

Center	Internship #	Area	Description	Time frame
		Systems	operations support focuses on: (1) tedious, highly repetitive, long-duration tasks that can be off-loaded from astronauts and (2) rapid response for addressing emergency, time-critical situations. Example tasks include: mobile camera platform, inspection, emergency response, site preparation, instrument deployment. This project involves software development in C/C++ (embedded, robot navigation, and interactive 3D graphics).	
ARC	ARC1-19-08-AN	Lunar & Planetary Surface Systems	Advanced networking software tools, techniques, and technologies, for improved bandwidth, latency, reliability, and administration of supercomputing interconnects, LANs, and WANs. Internship: Perform established networking task or study one advanced networking approach.	Anytime
ARC	ARC1-20-08-AN	Lunar & Planetary Surface Systems	Advanced software tools, techniques, and technologies for managing the physical plant of a large supercomputing facility, including significant changes to equipment, floorspace, electrical power, and air/water cooling	Anytime
ARC	ARC1-21-08-AN	Lunar & Planetary Surface Systems	Activity Planning Software Tools: Design, development and evaluation of activity planning software tools for human and robotic space and ground operations. These efforts are currently being applied on robotic Mars surface missions as well as in studies to assess the effects of micro-gravity countermeasures on astronauts. Skills required to support this work include computer science, software engineering, and human-computer interaction	Jan 2008 - Dec 2008
ARC	ARC1-22-08-AN	Ground Operations	Risk and Knowledge Management Software Systems: Design, development and evaluation of risk and knowledge management software systems to support safety and quality efforts at NASA, especially for the new Constellation Program which will be replacing the Space Shuttle Program over the next decade. Skills required to support this work include computer science, software engineering, and human-computer interaction.	Jan 2008 - Dec 2008
ARC	ARC1-23-08-AN	Lunar & Planetary Surface Systems	Overall Research Goal: To develop and validate countermeasures to mitigate risks to neurobehavioral functions and enhance health, performance and safety of crews during extended duration spaceflight. Objectives: 1. To study how individuals adapt in space analog environments (e.g., isolation, confinement, and sustained operations), and to identify individual characteristics that best predict team performance; 2. To compare the effectiveness of selected countermeasures for mitigating performance	Sept 2007-2008

Center	Internship #	Area	Description	Time frame
			impairments of individuals exposed to high-stress, high workload situations; 3. To develop non-intrusive, portable methods for self-detection and correction of adverse changes in physiological states, mood states, and cognitive, perceptual, and neuromotor function; 4. To develop a real-time physiological model that will predict or classify individual and team performance. Skills: (preferred) 1. Some programming experience with Visual Basic, C/C++, Matlab. 2. Some familiarity with digital signal processing techniques, in particular human biomedical data (e.g., ECG, EEG). 3. Some experience with neural network based models	
ARC	ARC1-24-08-AN	Spacecraft	CEV cockpit controls & displays/HSIG (Human System Inetgration Group) controls & displays: Engineering internship to work on programming, modeling, analysis, and calibration for computer controlled haptic interfaces.	FY2008-2009
ARC	ARC1-25-08-AN	Spacecraft	CEV cockpit controls & displays/HSIG (Human System Inetgration Group) controls & displays: Engineering internship to work on programming, modeling, analysis, and calibration for computer controlled seat vibration simulator.	FY2008-2009
ARC	ARC1-26-08-AN	Lunar & Planetary Surface Systems	Exploration missions will involve distributed team collaboration and decision making, including space crews on the ISS or lunar surface and support personnel on earth. Neurocognitive and psychological methods for assessing personnel readiness to perform will need to be developed and evaluated in laboratory and analogue environments. Internship will focus on pilot testing of tools.	Summer '07
ARC	ARC1-27-08-AN	Lunar & Planetary Surface Systems	Exploration missions will involve distributed team collaboration and decision making, including space crews on the ISS or lunar surface and support personnel on earth. Neurocognitive and psychological methods for assessing personnel readiness to perform will need to be developed and evaluated in laboratory and analogue environments. Internship will focus on predictive validity study of RTP tools in laboratory environment, test ability to predict stress and fatigue.	2007-08 academic year
ARC	ARC1-28-08-AN	Lunar & Planetary Surface Systems	Exploration missions will involve distributed team collaboration and decision making, including space crews on the ISS or lunar surface and support personnel on earth. Neurocognitive and psychological methods for assessing personnel readiness to perform will need to be developed	Summer + 2008-09 academic year

Center	Internship #	Area	Description	Time frame
			and evaluated in laboratory and analogue environments. Internship will focus on analysis of data from predictive study.	
GRC	GRC1-01-08-AN	Lunar & Planetary Surface Systems	Navigation for Spacecraft and Lunar and Planetary Surface Systems The student will develop performance analysis of lunar navigation systems in support of orbit determination, geo-locating for robotic and manned rovers as well as EVA. Using and extending existing software tools that are part of the Space Navigation Computational Laboratory (SNCL) the student will employ Dilution-of-Precision (DoP), generalized DoP and full covariance-based techniques to analyze systems employing inertial, Earth-based and in-situ orbiting navigation resources. Currently contemplated studies include those focused on Launch and Early Orbit Phase (LEOP) as well as an analysis of beacon assets, deployed on the moon's surface.	Anytime
GRC	GRC1-02-08-SU	Lunar & Planetary Surface Systems	GRC1-01707AN - Description of General Research Work To Be Performed: Lunar dust is a major issue for materials and equipment used on the moon. Developing an understanding of the effect of dust on various materials used in space suits which will be exposed to lunar dust is necessary for up-coming missions. Baseline studies of space suit samples exposed to dust in the Apollo program using microscopy and other chemical analysis will be carried out based on availability. A selection of fabrics and other materials proposed to be used in advanced surface suits for up-coming missions will be exposed to lunar dust simulants, analyzed and compared to previous results.	Summer
GRC	GRC1-03-08-SU	Lunar & Planetary Surface Systems	GRC3-01807AN - Silica aerogels are attractive candidates for many unique thermal, optical, catalytic, and chemical applications because of their low density and high mesoporosity. However, their inherent fragility has restricted their use to applications where they are not subject to any load. Crosslinking silica aerogels with polymer significantly increases the strength of the aerogel with only a small effect on density or porosity. In addition, at very low densities, the aerogels crosslinked with a di-isocyanate are somewhat flexible. To enhance this property and make the monoliths more robust, synthesis of different formulations using more flexible linkages in the polymer backbone is proposed. Characterization and mechanical testing will be done on the monoliths produced and the properties will be optimized.	Summer
GRC	GRC1-04-08-AN	Lunar & Planetary	GRC1-01207AN - The Space-Rated Lithium-ion Battery Task of the Exploration Systems Mission	Anytime

Center	Internship #	Area	Description	Time frame
		Surface Systems	Directorate Power Subsystem of the EVA Project is responsible for developing and evaluating next generation lithium-ion cells and batteries. The student will perform work in support of this task. The student's duties will entail characterizing, testing and evaluating state-of-the-art battery cells for their ability to meet the anticipated mission requirements for many Exploration missions. The intern will learn about batteries and other energy storage devices, how to characterize battery cells, how to perform battery cell testing, and how to assess cell performance. A Chemical Engineer, Mechanical Engineer or Electrical Engineer would best fit this position. Mostly lab work will be performed, and analysis of data generated in the lab using spreadsheets will be required. Skills required include basic laboratory skills, good analytical skills for understanding of data and performing data analysis, and proficiency with spreadsheets for data manipulation and plotting. The ability to utilize various laboratory instrumentation, write simple algorithms and learn simple programming techniques for the test equipment may be needed, but these skills can be taught on the job. We are willing to work with the student to determine whether a full time or part time position will fit the needs of both the student and the organization.	
GRC	GRC4-05-08-SU	Spacecraft	GRC1-01507SU - The student will be involved in the characterization of fuel/gas leak sensors and environmental chemical sensors, processing of data associated with these sensors, and other activities associated with the Chemical Sensors Team for CLV, CEV and ISRU. The student will be involved in measurement of the response of a variety of different types of gas sensors in range of temperatures and environments. These sensor types include diodes, electrochemical cells, and resistors. This work will include operation of a gas sensor testing system, compiling the resulting data, and some computer programming. The gas sensor testing system is computer controlled with the ability to flow several gases over a wide flow range. The student will operate this gas sensor testing system and use it to characterize samples. Other duties in support of the chemical sensor program will be performed as assigned. An Electrical Engineering major is preferred with programming knowledge.	Summer
GRC	GRC1-06-08-AN	Lunar & Planetary Surface Systems	GRC AW1: Excavation, Traction, and Material Flowability Measurements: Establish preparation recipes for lunar-equivalent soil using triaxial shear tests, plate penetration tests, and shear vane test. Use available wheel constructions to determine traction on lunar-equivalent soils under	Anytime

Center	Internship #	Area	Description	Time frame
			a matrix of operating conditions. Acquire excavator blades and measure the horizontal and vertical forces to dig in lunar-equivalent soil. Test validity/accuracy of traditional granular flow equations on lunar-equivalent soil by acquiring industrial shear and flow testing equipment and during tests seeking to identify the physics parameters that may be key to flow.	
GRC	GRC1-07-08-AN	Lunar & Planetary Surface Systems	GRC AW2: Discrete Element Modeling Calculation to reproduce simple measurements above (GRC AW1): Execute in a high performance computing environment at GRC. Plate penetration and wheel traction models are simplest start that has tight relevance to measurements. From this determine what particle parameters are needed to get responses equivalent to lunar-equivalent soil (Create particle ensembles that represent lunar-equivalent soil). This is a building block for future more complicated simulations.	Anytime
GRC	GRC1-08-08-AN	Lunar & Planetary Surface Systems	In space exploration, In-Situ Resource Utilization (ISRU) is a concept of utilizing resources available on an exploring planet such as Moon and/or Mars. Student internship opportunities exist for a research of extracting oxygen, water and other substances essential for human life support from lunar regolith through a vibrofluidization reactor.	Anytime
GRC	GRC4-09-08-SU	Spacecraft	Most of current repairing work of electrical components in space exploration missions is based on the approach of replacing a troubled module (PCB, computer, etc.) with a new unit. Although this approach is easy to be performed from the maintenance point of view, it is difficult to assure availability of such replacing modules in a timely and cost effective manner to where they are needed. The Component-Level Electrical Assembly Repair (CLEAR) is a new approach of repairing electrical components at the component level rather than the module level. Student internship opportunities exist for developing repair techniques of components such as soldering electrical components under micro or low gravity environment, designing diagnostic systems for troubleshooting, and developing inspection methods of repaired components, etc.	Summer
GRC	GRC1-10-08-AN	Lunar & Planetary Surface Systems	A catalytic combustion reactor is a device which converts a gas mixture (CO ₂ , CO, N ₂ , H ₂ , H ₂ O, etc.) into more useful products for space exploration missions. Such useful products include oxygen which is used for human life support and fuels such as methane. Students under this internship are expected to work for various lab assignments such as performing experiments under NASA mentors' supervision to optimize the performance of the reactor and	Anytime

Center	Internship #	Area	Description	Time frame
			analyzing experimental data. Internship opportunities also exist for developing a numerical model of the reactor.	
GRC	GRC4-11-08-AN	Spacecraft	Fire hazard is one of major safety concerns for manned space crafts and lunar habitats. Student internship opportunities exist under GRC's extensive research and development projects for spacecraft fire safety. In the fire prevention area, flammability of materials is examined with various test methods which simulate a low gravity environment. In the fire detection area, GRC is working to develop various new detection systems for space crafts such as new fire detection systems that sense both particles and the signature of gas composition. In the fire suppression area, a focus is on establishing unique fire extinguisher system for each different space craft such as the new Orion space craft under the Constellation project.	Anytime
GRC	GRC1-12-08-AN	Lunar & Planetary Surface Systems	At GRC, a wide range of mechanical systems for the next generation lunar rover are developed and tested through the test vehicle called Modular Mobility Test Demonstration (MMTD) vehicle. The Simulated Lunar OPERATION (SLOPE) facility provides the MMTD a test environment of a simulated lunar surface terrain with up to 45 degrees of inclination. Some of important mechanical issues include terramechanics (the study of interactions between vehicle wheels and various terrains specifically the simulated lunar surface), drive train, and suspension. Student internship opportunities are available for designing and fabricating mechanical components, conducting various experiments to validate the performance of the MMTD vehicle, etc.	Anytime
GRC	GRC2-13-08-AN	Ground Operations	Development of Human Body Models for Orion Crew Injury Prediction and Prevention: The design of Orion requires that NASA develop a high fidelity understanding of the human body's ability to withstand the landing forces generated by the vehicle during landing. Prediction of crew injuries during landing is critical to mission success and is a major design driver for the program. Currently the Brinkley model is used as the standard for crew injury predictions. This model is based primarily on empirical data and represents the human body analytically as a simple single degree-of-freedom oscillator in the spinal, side-to-side and chest in and out directions. The shortcoming of the Brinkley model is it is specifically designed for ejection seat injury predictions using a very specific seat arrangement and restraint system. The model is unable to assess the effects resulting from alternate seat designs, constraint systems, crew suits or	Anytime

Center	Internship #	Area	Description	Time frame
			helmets. Furthermore, the Brinkley model is based on limited test data and does not utilize the latest technology that is available from the automotive, aerospace or biomedical communities. More recently these industries have employed finite element technology to develop human body models to simulate human behavior during events such as automobile crashes. These models are able to predict full three dimensional human responses during an event such as a crash and airbag deployment are able to reliably predict the loading and deformations that occur within the human body. The Exploration System Mission Directorate (ESMD) is employing this technology for Orion and crew member injury predictions using the following approach; 1) leverage existing human body finite element modeling technology that has been developed for the automotive, aerospace and biomedical communities and further develop this modeling technology for application to Orion. 2) Collect and develop injury criteria applicable to Orion. 3) Enhance models to accommodate candidate seat designs, constraint systems, crew suits and helmets. 4) Integrate human body models into Orion landing scenarios and generate human body response. 5) Assess the human body model and generated response to accepted injury criteria as well as compare new human body model to currently used Brinkley model. Final products will be validated human body finite element models and associated injury criteria capable of modeling the crew members, crew seats, harness, crew suit and helmet and a validated set of injury criteria for Orion crew member injury predictions.	
GRC	GRC3-14-08-AN	Propulsion	Research Combustion Laboratory at GRC is an extensive facility to test small to medium size rocket engines. Currently many tests with non-toxic cryogenic propellants which will be used for CEV and LSAM are underway. Internship opportunities are available for many lab related assignments under this project.	Anytime
GRC	GRC1-15-08-AN	Lunar & Planetary Surface Systems	The Space Environmental Durability Branch (RPY) of the Power and In-Space Propulsion Division at GRC studies the effects of space and lunar environments on materials and components used on the external surfaces of spacecraft and satellites. Examples of such environmental factors include atomic oxygen present in Low Earth Orbit (LEO), ultraviolet radiation in space, thermal environments, and lunar dust on the moon's surface. RPY also develops methods for predicting and mitigating such environmental effects. Student internship opportunities are available for various types of experimental and	Anytime

Center	Internship #	Area	Description	Time frame
			analytical work under this area of research and development.	
GRC	GRC1-16-08-AN	Lunar & Planetary Surface Systems	Regolith & Environment Science and Oxygen & Lunar Volatile Extraction (RESOLVE) is a project contributed by 5 NASA centers (JSC, KSC, JPL, GRC, and MSFC), universities and industries to develop an entire ISRU system of extracting oxygen and other volatiles from lunar soil. The focus of this engineering project is to build such a system; which is cost effective, high production rate, reliable, and safe considering the entire lifecycle of excavating lunar soil up to disposing waste from the production. Student internship opportunities may be available for experiments designing/testing components, and other miscellaneous duties for developing the Engineering Breadboard Unit which is a small scale prototype unit to validate the RESOLVE concept through the use of simulated lunar soil.	Anytime
GRC	GRC4-17-08-SU	Spacecraft	Working with NASA experts, the incumbent will research a range of inputs to describe the Orion Crew Exploration solar array design and operational characteristics, such as SOA solar cell properties. Using these inputs, the incumbent will conduct performance analyses using SOA codes to explore the solar array electrical and thermal operational envelopes in Earth orbit and lunar orbit. Based on this research, the incumbent will recommend optimum design and operation strategies for the Orion solar array within the context of overall vehicle electrical power system performance. At the conclusion of the period of performance, the incumbent is expected to prepare a presentation and/or written report and deliver an oral report on work accomplished and conclusions drawn.	Summer
GRC	GRC4-18-08-AN	Spacecraft	Space Power Systems NASA GRC has a lead role in the definition and development of electric power system specifications for all Constellation vehicles (CLV, CEV, LSAM, etc.). As such, GRC is currently developing a Power System Test Facility to develop and validate interface specifications, verification plans, and refine system-level models for the Constellation program. The hardware to be developed includes: solar array regulators, primary and secondary distribution switch units, battery charge controllers, load simulators, and system controllers. A student researcher is required to assist in the design and development of prototype hardware for an initial CEV Power System Test Bed. The researcher should have a solid background in electrical engineering, including analog and digital hardware design and experience with power	Anytime

Center	Internship #	Area	Description	Time frame
			electronics. Some experience with microprocessors and the C programming language is also a plus. Preferred work schedule is full-time, on-site at NASA GRC in Cleveland, OH	
JSC	JSC1-01-08-AN	Lunar & Planetary Surface Systems	Student Intern will participate in the design of in-situ resource utilization oxygen production pilot plants.	Winter & Anytime
JSC	JSC1-02-08-SS	Lunar & Planetary Surface Systems	Support Life Support Air Revitalization activities (EC Priority #2): The Crew and Thermal Systems Division is seeking interns to support Lunar and planetary surface systems as well as spacecraft life support systems activities. Intern activities would support air revitalization technology development and testing. Systems and areas of interest include CO2 and Moisture removal technology evaluations, trace contaminant control technology evaluations, small scale flow bench performance characterization of different CO2, Moisture, and TCC removal material. Other activities would involve design and build-up of hardware to support life support technology evaluation.	Spring & Summer
JSC	JSC1-03-08-AN	Lunar & Planetary Surface Systems	Exploration Task Simulator –system development and validation PURPOSE OF PROJECT: To create and interdisciplinary consistent set of tests that can be used for both EPSP and ECP testing and potentially for postflight testing. ACTIVITIES TO INCLUDE IN TESTS - including 14-day Bed Rest with ECP where subjects perform 6 hour EVA simulation each day (assess metabolic rates, ground reaction forces, task mobility, etc.) • Pivot Test - Subject travels down straight path, turns and returns to start point – consider alternative surfaces (i.e., foam flooring). • Agility • Ladder Task • Kneel & Recovery • Fall & Recovery • Shoveling • Ramp Climb - Simulates incline/decline of walking on lunar surface, craters etc. • Rock Pick-Up - (Object pick-up and lift) • Ambulation • Hatch Opening & Egress through hatch (Bend & step) • Seat Egress, sit to stand. - intended to be CEV seat, not the rover seat in a light weight suit. • Jump down onto unstable surface	Flexible – September 2006 through August 2006

Center	Internship #	Area	Description	Time frame
			OVERVIEW OF PARAMETRIC SUIT TEST PLANNED • Measure metabolic rates as a function of speed (shirt-sleeve (SL) & suited) • Assess inertial mass as function of mass + weight (SL & suited). • Variable centers of gravity (CG) - SL & suited • Assess inertial mass as function of mass+ weight with varied CG (SL & suited) -include balance control measures • Later perform studies using alternative space suits which supports addition of up to 100lbs - will help understanding of inertial mass component • Change suit pressures to understand pressure volume contributions	
JSC	JSC1-04-08-AN	Lunar & Planetary Surface Systems	Build polymer lithium-ion battery packs for use in a vacuum environment (non-pressurized). State of the art lithium-ion polymer cells of moderate and high rates will be configured into battery packs and tested under extreme temperature and pressure environments. The optimum pressures required for constraining the packs will be studied. Long term testing will also be performed. Safety tests that include overcharge, overdischarge and external shorts at a cell and module level will be performed under vacuum condition to determine the cell and module characteristics under abusive conditions.	6 months
JSC	JSC1-05-08-AN	Lunar & Planetary Surface Systems	Perform data analysis of radiation detection data collected at numerous test facilities to the facility dosimetry. Recommend and support additional detector testing as necessary to prove radiation instrument design.	Fall/Spring/Summer
JSC	JSC1-06-08-AN	Lunar & Planetary Surface Systems	Write VHDL code for a Reed Solomon codec with Space to Space Communication System(SSCS) compatibility for the Software Defined Radio (SDR). Include both RS open standards as well as L64710.	Fall/Spring semester or summer
JSC	JSC1-07-08-AN	Lunar & Planetary Surface Systems	Write VHDL code for a Low Density Parity Check (LDPC) codec for the Software Defined Radio (SDR).	Fall/Spring semester or summer
JSC	JSC1-08-08-AN	Lunar & Planetary Surface Systems	Design a QFDM (or QAM) module that is WiMax compatible for the Software Defined Radio (SDR).	Fall/Spring semester or summer
JSC	JSC1-09-08-AN	Lunar & Planetary Surface Systems	Develop a radiation hardened local wireless network for NASA's lunar base. Current systems are not likely to perform well enough in the radiation environment of deep space. This is an incremental development of an existing open source or government owned protocol such as WiMax 802.16e. This project is a multi-year project which would be worked at the university	Fall/Spring semester or summer

Center	Internship #	Area	Description	Time frame
			and on-site at JSC.	
JSC	JSC1-10-08-AN	Lunar & Planetary Surface Systems	Develop a re-programmable logic platform suitable for implementing a radiation hardened local wireless network. A multi-party collaborative R&D effort is envisioned in which different parties develop various versions of the functional elements (or Arithmetic Logic Units), the routing architectures, VHDL or netlist conversion and translation tools, and embedded microcontrollers. This project is a multi-year project which would be worked at the university and on-site at JSC.	Fall/Spring semester or summer
JSC	JSC1-11-08-AN	Lunar & Planetary Surface Systems	Evaluation of combined visible/ thermal infrared handheld camera data for potential use in astronaut sortie characterization of lunar and Martian landing site geological materials and surface properties (particle size and composition). Characterization will be performed using terrestrial material analogs in the JSC/Houston region. Intern will assist in collection of diurnal field data as well as integration, analysis, and geological interpretation of visible and thermal infrared data.	Spring or Fall
JSC	JSC1-12-08-AN	Lunar & Planetary Surface Systems	A new project has been started in In-situ Resource Utilization for the moon. This project consists of a bioreactor that uses cyanobacteria to attack and corrode lunar soil in order to extract useful products (oxygen, iron, silicon) for use on the moon. It will use a unique bioreactor design in which fiber optics light pipes provide light energy to the cyanobacteria. The resulting biomass is recycled after removal of the desired resources. This project requires knowledge of general and molecular microbiology, general and analytical chemistry, basic biotechnology and engineering.	Year around; Minimal duration of single visit - 4 months
JSC	JSC4-13-08-AN	Spacecraft	Astronauts experience alterations in multiple physiological systems following their return to Earth due to adaptive responses that occur during exposure to the microgravity conditions of space flight. These changes may lead to disruption in the ability to ambulate and perform functional tasks during the initial reintroduction to a gravitational environment following a prolonged transit. These disturbances may cause decrement in performance of operational tasks immediately following landing on a planetary surface. Therefore, the goals of this interdisciplinary project are to: 1) Develop a set of functional tests for pre and postflight testing of astronauts; 2) determine the effects of short and long-duration space flight on functional performance and 3) map the relationship between changes in functional performance and the physiological alterations that occur as a result of exposure to space flight.	3 months Fall/Spring/ Summer
JSC	JSC4-14-08-AN	Spacecraft	Perform testing and data analysis of an advanced air monitoring system being proposed for ISS and CEV. Testing will include sensor accuracy, EMI,	Fall/Spring/Summer

Center	Internship #	Area	Description	Time frame
			RF stability, and sensor life	
JSC	JSC4-15-08-AN	Spacecraft	The Materials Science of Manned Spacecraft Radiation Shielding – Crew dose, materials dose, and avionics single event effects (SEE) environments a) Use the FLUKA (http://www.fluka.org/) ionizing radiation transport code to explore the effectiveness of various materials and materials combinations in attenuation of cosmic and solar cosmic ray dose to the interior of relatively massive (compared to robotic vehicles) manned spacecraft. The objective here is to compare different materials in simple geometries so that materials effects on secondary particle production and stopping power can be reported and visualized directly with no complications from specific spacecraft configuration effects.	Spring/Fall/Summer
JSC	JSC4-16-08-AN	Spacecraft	Geomagnetic storms, traveling ionospheric disturbances (TIDs), and solar cycle effects on neutral atmosphere. Predicting the scale of the attitude control or satellite drag anomalies expected as a result of geomagnetic storm events or as the upper atmosphere becomes denser during geomagnetic storms and/or during the next solar maximum is the objective of this project.	Spring/Fall/Summer
JSC	JSC4-17-08-AN	Spacecraft	International Space Station as a nano/micro satellite base (an evolution of the sounding rocket base (Wallops, White Sands, Poker Flats etc. idea as suggested by the free launch services provided for micro satellite and nano satellites by ESA on the Ariane launcher and used extensively by Surrey Satellite customers. a) Feasibility – assessment of earth-to-orbit transportation opportunities to ISS in the post Shuttle era. b) Concept – multi-satellite carrier to attach to ISS externally and provide controlled mechanical deployment/launch over some range of vectors compatible with ISS safety (collision avoidance). c) Launch opportunities for satellite carrier assembly – Progress, Soyuz, ESA/ATV, JAXA/HTV, Commercial Carriers (COTS Program), Orion.	Spring/Fall/Summer
JSC	JSC4-18-08-AY	Spacecraft	AGC Solution for UWB Proximity High-Resolution Tracking System. An AGC subsystem is designed to dynamically compensate the different spatial loss to each receiving antenna. The integration with current UWB Proximity High-Resolution Tracking System is required.	Spring/Fall
JSC	JSC4-19-08-AY	Spacecraft	UWB-TDOA 3D Tracking. A comprehensive study on UWB-TDOA 3D Tracking includes algorithm development, Matlab simulation and test configuration and set-up. The study is an extension of the accomplished UWB-TDOA 2D Tracking study. A final report is required.	Spring/Fall

Center	Internship #	Area	Description	Time frame
JSC	JSC4-20-08-AY	Spacecraft	Study on Multi-user Access Mechanism for UWB Communications and Tracking. The study is to define the multi-user access mechanism (TDMA, CDMA or others) for the UWB Communications and Tracking system developed at NASA/JSC. Currently the system is to communicate with and track one single user. It is required to accommodate all existing functionalities currently in the single user system into the multi-user system by using so-defined multi-user access mechanism. The study is required to use UWB PulsON 210 radios from Time Domain Corporation.	Spring/Fall
JSC	JSC4-21-08-AY	Spacecraft	The Materials Science of Manned Spacecraft Radiation Shielding – Crew dose, materials dose, and avionics single event effects (SEE) environments a) Use the FLUKA (http://www.fluka.org/) ionizing radiation transport code to explore the effectiveness of various materials and materials combinations in attenuation of cosmic and solar cosmic ray dose to the interior of relatively massive (compared to robotic vehicles) manned spacecraft. The objective here is to compare different materials in simple geometries so that materials effects on secondary particle production and stopping power can be reported and visualized directly with no complications from specific spacecraft configuration effects.	Spring/Fall/Summer
JSC	JSC4-22-08-AY	Spacecraft	Geomagnetic storms, traveling ionospheric disturbances (TIDs), and solar cycle effects on neutral atmosphere. Predicting the scale of the attitude control or satellite drag anomalies expected as a result of geomagnetic storm events or as the upper atmosphere becomes denser during geomagnetic storms and/or during the next solar maximum is the objective of this project.	Spring/Fall/Summer
JSC	JSC4-23-08-AY	Spacecraft	International Space Station as a nano/micro satellite base (an evolution of the sounding rocket base (Wallops, White Sands, Poker Flats etc. idea as suggested by the free launch services provided for micro satellite and nano satellites by ESA on the Ariane launcher and used extensively by Surrey Satellite customers. a) Feasibility – assessment of earth-to-orbit transportation opportunities to ISS in the post Shuttle era. b) Concept – multi-satellite carrier to attach to ISS externally and provide controlled mechanical deployment/launch over some range of vectors compatible with ISS safety (collision avoidance). c) Launch opportunities for satellite carrier assembly – Progress, Soyuz, ESA/ATV, JAXA/HTV, Commercial Carriers (COTS Program), Orion.	Spring/Fall/Summer
JSC	JSC4-24-	Spacecraft	AGC Solution for UWB Proximity High-Resolution	Spring/Fall/S

Center	Internship #	Area	Description	Time frame
	08-AY		Tracking System. An AGC subsystem is designed to dynamically compensate the different spatial loss to each receiving antenna. The integration with current UWB Proximity High-Resolution Tracking System is required.	ummer
JSC	JSC4-25-08-AY	Spacecraft	UWB-TDOA 3D Tracking. A comprehensive study on UWB-TDOA 3D Tracking includes algorithm development, Matlab simulation and test configuration and set-up. The study is an extension of the accomplished UWB-TDOA 2D Tracking study. A final report is required.	Spring/Fall/Summer
JSC	JSC4-26-08-AY	Spacecraft	Study on Multi-user Access Mechanism for UWB Communications and Tracking. The study is to define the multi-user access mechanism (TDMA, CDMA or others) for the UWB Communications and Tracking system developed at NASA/JSC. Currently the system is to communicate with and track one single user. It is required to accommodate all existing functionalities currently in the single user system into the multi-user system by using so-defined multi-user access mechanism. The study is required to use UWB PulsON 210 radios from Time Domain Corporation.	Spring/Fall/Summer
JSC	JSC4-27-08-AY	Spacecraft	The Subject Loading Device (SLD) provides loading of a crew member to allow for walking and running in micro-gravity environment. The Subject Load device is part of the Treadmill with Vibration Isolation & Stabilization (TVIS) system onboard the International Space Station (ISS). The SLD design shall fit within a pre-defined volume, provide loading range of at least 20-110 lbs with an obtainable resolution of no greater than 2 lbs between load settings, visually display the load value, minimize load variability due to astronaut vertical displacement while running/walking (not to exceed 6 lbs/in with goal of less than 4 lbs/in), and have a minimum operational life of 5 years. External supply of power will be available but is limited to 50 Watts.	
LaRC	LRC1-01-08-SU	Lunar & Planetary Surface Systems	Rover-Electronic Design & Algorithm Development Using LabVIEW	Summer 2008
LaRC	LRC1-02-08-SU	Lunar & Planetary Surface Systems	The projects will involve: (1) Developing educational content for Busch Gardens so that their visitors can learn about the ARES 1 rocket & compare the Gs of the rocket to the roller coasters; (2) Developing content for the physics show at Busch Gardens that they will be producing on rolloer coasters on the Moon in 2050; and (3) Developing content for an interactive online game that shows the importance	Summer 2008

Center	Internship #	Area	Description	Time frame
			of mapping for exploration: look back at the map that John Smith did in 1608 and then develop mapping of the moon and Mars to look for potential landing sites for water.	
LaRC	LRC1-03-08-SU	Lunar & Planetary Surface Systems	Participants will work with NASA Digital Learning Staff to design and test distance learning modules intended for delivery via videoconferencing to schools, informal education sites, & other NASA Centers. Specific skills required include digital media production, research activities, & technical/media writing. Proficiency with PowerPoint, Photo Shop, and/or video editing software recommended. Content for modules will be associated with Lunar & Planetary Surface Systems, Propulsion, and Spacecraft.	Summer 2008
LaRC	LRC1-04-08-SU	Lunar & Planetary Surface Systems	Develop strategies to attract STEM majors to NASA workforce	Summer 2008
LaRC	LRC1-05-08-SU	Lunar & Planetary Surface Systems	Design & integration of a robotic platform for science instrument testing: Our efforts this year focused on designing the robot & integrating the components, and next year's efforts will be heavily focused on software. There are many possibilities for algorithms relating to autonomous mobility, navigation based on stereo, omni-directional, & thermal imagers, in addition to a litany of tasks from image registration, to behavioral robotic intelligence, to user interfaces for robot guidance & supervision.	Summer 2008
LaRC	LRC4-06-08-SU	Spacecraft	Performance & lifetime analysis of systems	Summer 2008
LaRC	LRC4-07-08-SU	Spacecraft	Exploration communications & outreach	Summer 2008
LaRC	LRC4-08-08-SU	Spacecraft	Analysis of Dynamic Stability Experimental Data in Support of Project Orion & Planetary Entry Capsules: Dynamic stability data from various sources will be compared to better understand the strengths & weaknesses of different test techniques & facilities. This analysis will help identify the best facility to obtain data for different blunt body configurations and applications. The comparisons will also be used to quantify uncertainties on the measured aerodynamic coefficients & the sources of error in each facility.	Summer 2008
LaRC	LRC4-09-08-SU	Spacecraft	Structures & materials relating to fabrication	Summer 2008
LaRC	LRC4-10-08-SU	Spacecraft	The potential topic areas are: (1) Mid-IR laser based Differential Absorption Lidar (DIAL) development for water vapor detection: The student will be involved in modeling & simulation of water vapor sensing on Mars & other planetary atmospheres; & in addition will analyze coherent, direct and hybrid detection based system architectures. (2) Mid-IR laser based DIAL for ice	Summer 2008

Center	Internship #	Area	Description	Time frame
			detection: The student will be involved in modeling & simulation of ice detection on Mars & other planetary surfaces using differential absorption schemes. (3) Frequency Modulated (FM) CW lidar development for CO ₂ sensing at near-IR wavelengths: The student will design & develop FMCW lidar architecture suitable for CO ₂ profiling of Martian environment from orbiting platforms. (4) Coherent laser radar for 3D imaging of hard targets using near-IR wavelengths: The student will study coherent laser radar technologies for terrain mapping, instrument landing, & autonomous docking applications for Lunar & Mars surfaces. The wavelengths of interest are in the range 1-2 microns. (5) Deep-UV wavelength based chem-bio detection for mineralogical & life signature characterization: The student will experimentally analyze lunar & Martian soil simulants at deep UV wavelengths based on laser-induced fluorescence & Raman spectroscopy. The immediate interest will be in the wavelength domain 193-210 nm & the experiments could be extended to other wavelengths.	
LaRC	LRC4-11-08-SU	Spacecraft	Nanomaterials characterization for aerospace applications	Summer 2008
LaRC	LRC4-12-08-SU	Spacecraft	Nanoscale surface imaging via resonant difference-frequency atomic force ultrasonic microscopy	Summer 2008
LaRC	LRC4-13-08-SU	Ground Operations	Develop integrated diagnostic and prognostic aeroseroelastic methods to generate static & dynamic load constraints due to structural damage and upset conditions for adaptive control system. The focus will be on the following: damage characterization & residual strength; rapid modeling & analysis methods; dynamic impact simulation; and probabilistic methods.	Summer 2008
LaRC	LRC4-14-08-SU	Spacecraft	Stability & dynamics for entry vehicles	Summer 2008

GSFC: If you are selected for a summer internship at Goddard Space Flight Center, you are required to pay \$3,500 for a unified summer program that provides infrastructure, housing and other activities that will yield in an enhanced summer experience. Your Space Grant Consortium may be able to help with this expense and/or your mentor may be able to contribute as well. However, ultimately, payment of this fee is your responsibility.

GSFC	GSFC1-01-08-AN	Lunar & Planetary Surface Systems	Software & Avionics supporting the Constellation Program. Three (3) internships are available for the following majors: EE, Comp Sci, AA/Sys	Anytime
GSFC	GSFC4-02-08-AN	Spacecraft	Lunar Reconnaissance Orbiter (LRO) integration and test: http://lunar.gsfc.nasa.gov/missions FIVE internships are available for the following	Anytime

Center	Internship #	Area	Description	Time frame
			majors: EE, Mech Eng, Comp. Sci, AA/Sys, and Science	
GSFC	GSFC1-03-08-AN	Lunar & Planetary Surface Systems	Radiation Hardened electronics. Two internships are available for the following majors: EE, Mech Eng	Anytime
GSFC	GSFC1-04-08-AN	Lunar & Planetary Surface Systems	Robotics - Two internships are available for the following majors: EE, Mech Eng	Anytime
GSFC	GSFC1-05-08-AN	Lunar & Planetary Surface Systems	Lunar relay microsatellite with laser communication demonstration. FIVE internships are available for the following majors: EE, Mech Eng, Comp. Sci, AA/Sys, and Science	Anytime
GSFC	GSFC2-06-08-SU	Ground Operations	Use of a Fabry-Perot Interferometer for column carbon dioxide monitoring measurements in the atmosphere	Summer 2008
GSFC	GSFC2-07-08-AN	Ground Operations	Embedded (on-board/in-situ) science data processing applications using high performance hybrid (CPU/FPGA/DSP) platforms: Robotic path planning demonstration & internal R&D work doing SAR and Hyper-spectral data processing.	Anytime
GSFC	GSFC1-08-08-AN	Lunar & Planetary Surface Systems	Lunar Terrain Categorization: Classification with methods such as shape analysis, textural analysis, mathematical morphology, & shading analysis, as well as both unsupervised clustering & supervised classification will be investigated and evaluated, and SAR Data Hazard Analysis will be used to generate hazard maps using methods such as texture and mathematical morphology.	Anytime
GSFC	GSFC1-09-08-AN	Lunar & Planetary Surface Systems	Work assignments will be in the areas of power management and distribution such as in power supply design, converter and switch designs, solar array and battery analysis. Work will be performed under the guidance of branch senior engineers. Requirements: At least a junior or senior standing, with EE background.	Summer 2008
GSFC	GSFC1-10-08-AN	Lunar & Planetary Surface Systems	Development of an Ytterbium (Yb)-fiber laser pumped Optical Parametric Oscillator (OPO) for an atmospheric methane measurement instrument.	Summer 2008
GSFC	GSFC2-11-08-AN	Ground Operations	Design and testing of a holographic optical filter; such narrow band optical filters are important in wavelength division multiplexed systems and very useful in optical communication systems.	Summer 2008
GSFC	GSFC1-12-08-AN	Lunar & Planetary Surface Systems	Projects: (1) Develop an Expandable Reconfigurable Instrument Node as a Building Block for a Web Sensor Strand (ESTO/AIST Project): Involves development of two microwave sensors (for soil moisture) operating at L-band. The two sensors are separated physically by some distance. The technology being developed is to make these two transmitters to transmit signal in coherence with each other (phased lock	Summer 2008

Center	Internship #	Area	Description	Time frame
			loop). Since the two transmitters are physically separated, the phase locking of the two must be done through wireless technology. (2) Develop Microwave Heating System to Melt Moon Soil Sample (IRAD 2008): Involves design & development of a low frequency (1-2 GHz) microwave system that will concentrate microwave energy on a lunar soil sample. The heat generated in the sample due to microwave dissipation will melt the sample. (3) Low Frequency Microwave Sounder for Electron Density Estimation in Earth's and other Planetary Atmospheres (IRAD 2008): Involves the development of a very low frequency radar transmitter. When the antenna of such a system radiates into its surroundings, the antennas' near field as well as far field characteristics are measured. Based on these characteristics, & using powerful retrieval methods, the electron density profile of the antenna's surrounding can be computed. (4) Development of a Lightweight High Resolution Inverse Synthetic Aperture Radar for Planetary Subsurface Exploration (2008 IPP Project): Develop a very low frequency & yet ultra bandwidth radar in the frequency range 25-100 MHz. Very low frequency operation will allow the EM signal to penetrate 100's of meter of subsurface region. The ultra wideband width will allow seeing the subsurface at much higher resolution (1-2 m).	
MSFC	MSFC4-01-08-SU	Spacecraft	Autonomous rendezvous, capture, and docking; simulation and control of the six degree of freedom system operating on the Marshall flat-floor	Summer
MSFC	MSFC1-02-08-AN	Lunar & Planetary Surface Systems	Educational testbed for surface mobility study	Anytime
MSFC	MSFC1-03-08-AN	Lunar & Planetary Surface Systems	Radiation Effects on Electronics Modeling: Develop advanced models of the natural radiation environment to diagnose and predict the effects of Single Event Effects (SEEs) on modern electronic architectures.	Anytime
MSFC	MSFC1-04-08-AN	Lunar & Planetary Surface Systems	Reconfigurable Computers: Provide reconfigurable computing capability, resulting in reduction of flight spares and risk reduction for limited circuit lifetimes.	Anytime
MSFC	MSFC1-05-08-SU	Lunar & Planetary Surface Systems	Impact testing using a variety of projectiles simulating micrometeoroids, orbital and launch debris, and weather encounters (rain/hail) for testing and developing materials to ensure safer space exploration	Summer
MSFC	MSFC1-06-	Lunar &	Optical and detector technologies for applications	Summer

Center	Internship #	Area	Description	Time frame
	08-SU	Planetary Surface Systems	on the lunar and planetary surfaces	
MSFC	MSFC1-07-08-SU	Lunar & Planetary Surface Systems	Lunar CRater Observation Sensing Satellite (LCROSS). LCROSS is a mission scheduled to launch in October 2008 to study the composition of lunar soil near the south pole.	Summer
MSFC	MSFC4-08-08-SU	Spacecraft	Design, analysis and fabrication of space systems: In the Mechanical Design and Analysis Division of MSFC, the intern will have opportunities to perform development, design, analysis, and fabrication of aerospace structures or mechanisms. The intern will study and understand project requirements, develop concepts, do detailed design using 3D CAD modeling, use analysis tools to optimize components, do drawings to document the design, produce rapid prototypes of parts, and support flight hardware fabrication and testing. Time limitations would not allow the intern to be involved in all of these activities during one term; but, they would definitely be exposed to all and participate in most of the activities.	Summer
MSFC	MSFC1-09-08-AN	Lunar & Planetary Surface Systems	Microwave/Millimeter Wave Nondestructive Evaluation (NDE) Lab support	Anytime
MSFC	MSFC1-10-08-SU	Lunar & Planetary Surface Systems	Reconfigurable Computing: Computing resource modularity (interface modularity, processing modularity, and fault detection and mitigation)	Summer
MSFC	MSFC1-11-08-SU	Lunar & Planetary Surface Systems	With longer duration and distance space flights becoming necessary, the ability to predict and simulate space radiation exposure due to galactic cosmic rays (GCR) is crucial. These predictions are commonly used in space weather simulations as well as in radiation exposure and protection studies for microelectronics and astronauts. This study focuses on four of the most widely used GCR models where they will be benchmarked and validated against a database consisting of both light and heavy-ion GCR data. This work will provide a foundation for updating the Cosmic Ray Effects on MicroElectronics (CREME) 1996 model, an effort that is currently underway by the Cosmic Ray group at MSFC.	Summer
MSFC	MSFC1-12-08-SU	Lunar & Planetary Surface Systems	Autonomous object detection and avoidance (lunar rover, autonomous lander)	Summer
MSFC	MSFC1-13-08-SU	Lunar & Planetary Surface Systems	Autonomous vehicle system failure detection and response	Summer
MSFC	MSFC3-14-	Propulsion	Liquid engine system performance modeling &	Summer

Center	Internship #	Area	Description	Time frame
	08-SU		main propulsion system analysis. Includes current liquid rocket engines and future new & derivative engine analysis & predictions	
MSFC	MSFC4-15-08-SU	Spacecraft	Testing and development of Micrometeorite gun. Involves high voltage pulsed power, plasma, hypervelocity measurements, high speed imaging and diagnostics development for a facility for the study of micrometeorite impact. Specific areas of interest include the hypervelocity impact of small particles (10-150 um) with multi-layer cryogenic insulation samples at velocities of 20 km/sec. Diagnostics are needed for accurate size and speed measurements of these small hypervelocity particles.	Summer
MSFC	MSFC1-16-08-SU	Lunar & Planetary Surface Systems	Development of general purpose electric solenoid valve controller with advanced diagnostic capabilities. Involves programming a Digital Signal Processor (DSP) with C++ language to create an "intelligent" controller which electrically senses the state of closure of the valve using a reference resonator loop and a realtime FFT algorithm. Also involves some simulation with "SPICE" circuit emulation software.	Summer
MSFC	MSFC1-17-08-SU	Lunar & Planetary Surface Systems	Model for Radiation Effects on Electronics: Updating the space radiation environment in this model by evaluating various radiation environment models that are available in the literature. This task requires the applicant to read and understand papers on cosmic ray and solar energetic particle measurements and models. He/she also needs to understand how to access data bases on cosmic ray and solar energetic particle measurements. The applicant must also learn how to run the models. In some cases he/she will need to code the models. For this he/she will need a knowledge of Fortran because the models are written in Fortran. A knowledge of C would also be useful. His/her task will be to compare the models to the data and to conduct statistical analysis of this comparison in order to decide which model best describes the data.	Summer
MSFC	MSFC4-18-08-SU	Spacecraft	Digital Manufacturing: Simulation and validation of manufacturing processes for space vehicles	Summer
MSFC	MSFC1-19-08-SU	Lunar & Planetary Surface Systems	MSFC is developing a method to create lunar regolith simulants that will match the properties of the lunar surface. This process involves understanding the lunar components and how to quantify and reproduce them, and how they mix together on the Moon. A very active part of the project is the development and completion of the Figures of Merit algorithm to quantitatively compare particulate matter. Getting the values for this algorithm is a difficult and work intensive process that would be interesting and valuable work for future students.	Summer

Center	Internship #	Area	Description	Time frame
MSFC	MSFC4-20-08-SU	Spacecraft	Testing and development of Micrometeorite gun. Involves high voltage pulsed power, plasma, hypervelocity measurements, high speed imaging and diagnostics development for a facility for the study of micrometeorite impact. Specific areas of interest include the hypervelocity impact of small particles (10-150 um) with multi-layer cryogenic insulation samples at velocities of 20 km/sec. Diagnostics are needed for accurate size and speed measurements of these small hypervelocity particles.	Summer
MSFC	MSFC1-21-08-SU	Lunar & Planetary Surface Systems	Development of general purpose electric solenoid valve controller with advanced diagnostic capabilities. Involves programming a Digital Signal Processor (DSP) with C++ language to create an "intelligent" controller which electrically senses the state of closure of the valve using a reference resonator loop and a realtime FFT algorithm. Also involves some simulation with "SPICE" circuit emulation software.	Summer
MSFC	MSFC1-22-08-SU	Lunar & Planetary Surface Systems	Model for Radiation Effects on Electronics: Updating the space radiation environment in this model by evaluating various radiation environment models that are available in the literature. This task requires the applicant to read and understand papers on cosmic ray and solar energetic particle measurements and models. He/she also needs to understand how to access data bases on cosmic ray and solar energetic particle measurements. The applicant must also learn how to run the models. In some cases he/she will need to code the models. For this he/she will need a knowledge of Fortran because the models are written in Fortran. A knowledge of C would also be useful. His/her task will be to compare the models to the data and to conduct statistical analysis of this comparison in order to decide which model best describes the data.	Summer
MSFC	MSFC4-23-08-SU	Spacecraft	Digital Manufacturing: Simulation and validation of manufacturing processes for space vehicles	Summer
MSFC	MSFC1-24-08-SU	Lunar & Planetary Surface Systems	MSFC is developing a method to create lunar regolith simulants that will match the properties of the lunar surface. This process involves understanding the lunar components and how to quantify and reproduce them, and how they mix together on the Moon. A very active part of the project is the development and completion of the Figures of Merit algorithm to quantitatively compare particulate matter. Getting the values for this algorithm is a difficult and work intensive process that would be interesting and valuable work for future students.	Summer
MSFC		Spacecraft	Development and application of structural/thermal analysis and design software tools. Applications to spaceflight hardware and conceptual systems.	Anytime

Center	Internship #	Area	Description	Time frame
			Includes further development of NASA X-TOOLSS (eXploration Toolset for Optimization Of Launch and Space Systems) software.	
MSFC		Spacecraft	Thermal and structural analysis opportunities, including heat transfer, stress, fracture, fatigue, structural dynamics/loads, and vibroacoustics. Applications to spaceflight hardware and future lunar surface systems.	Anytime
SSC	SSC3-01-08-AN	Propulsion	Determination of the diffusion rate constant and buoyancy force balance at small concentrations for nitrogen contamination in hydrogen. The project would be the experimental determination of the rate of stratification of gaseous nitrogen in a container of hydrogen by introducing a small fixed amount of nitrogen in into a volume of hydrogen (or possibly helium for safety) and monitoring the stratification process.	Spring/Fall/Summer
SSC	SSC3-02-08-AN	Propulsion	Determination of the circumferential heat leak through a vacuum jacketed pipe carrying cryogenic fluid. The project would be the experimental determination of the circumferential temperature distribution and heat leak under cryogenic conditions for a vacuum-jacketed pipe in a horizontal orientation. One of the primary goals of the investigation would be the separation of the external radiation component from the convective component of heat transfer producing the circumferential temperature variation with a partially filled inner tube.	Spring/Fall/Summer
SSC	SSC3-03-08-SU	Propulsion	RFID Instrument Calibration Data Device. Design an RFID device to be placed on instrumentation and a read/write device so that a QA technician can easily check to see what the re-calibration date is, can set the new date and can interface this data with a computer system automatically.	Summer
SSC	SSC3-04-08-AY	Propulsion	Strain Gage Bonding Integrity Measurement Device. Design an intelligent Integrated System Health Management (ISHM) detector for strain gages which will use capacitive coupling techniques and computer intelligence to determine whether the gage is still properly bonded to the subject material. It is difficult to determine whether an anomaly is caused by an actual adverse event or simply by the strain gage losing integrity. This must be done in real time.	Fall/Spring
SSC	SSC3-05-08-AY	Propulsion	Characterization of strain levels in U-shaped Convolutes on cryogenic expansion joints. Collecting and analyzing strain readings from U-shaped convolutes for clarifying instrumentation techniques in support of rocket propulsion testing. The strain characterization will also be compared to an ANSYS finite element model to further substantiate the results.	Fall/Spring
SSC	SSC3-06-08-AY	Propulsion	Hardware-in-the-Loop Propulsion Test Systems Analytic Modeling. The goal of this project is to develop and validate the technology and processes for pre-test validation of facility	Fall/Spring

Center	Internship #	Area	Description	Time frame
			readiness relative to hardware response, planned test sequence execution and system detection and response to off-nominal performance situations. SSC analytic models of test facility propellant systems will be integrated with test facility hardware control systems and hardware to provide test like environments that enable test facility operational checkout and readiness verification. This project requires a combination of ME and EE disciplines and includes both systems development with regard to system architecture development and integration as well as thermo/fluid systems modeling and analysis, focusing on faster than real-time execution that enables real time assessment of test operations.	
SSC	SSC3-07-08-AY	Propulsion	Engine Test Altitude Simulation Test Stand Development. SSC has initiated construction of an engine test altitude test stand to support NASA's Ares 1 and Ares V upperstage, J-2X engine development. A sundry of unique technology and engineering design and analysis investigations/trades are needed. 1) Design investigations of pressure-fed chemical steam generator system (4800 lb/sec, 500 psi steam ejector system), including structural loads analysis, temporal transient performance investigations, system robustness/margin requirement definition & assessment, propellant supply sizing validation, etc.	Fall/Spring
SSC	SSC3-08-08-AY	Propulsion	Engine Test Altitude Simulation Test Stand Development. SSC has initiated construction of an engine test altitude test stand to support NASA's Ares 1 and Ares V upperstage, J-2X engine development. A sundry of unique technology and engineering design and analysis investigations/trades are needed. 2) Analytic model development and related investigations of altitude simulation diffuser performance	Fall/Spring
SSC	SSC3-09-08-AY	Propulsion	Engine Test Altitude Simulation Test Stand Development. SSC has initiated construction of an engine test altitude test stand to support NASA's Ares 1 and Ares V upperstage, J-2X engine development. A sundry of unique technology and engineering design and analysis investigations/trades are needed. 3) A sundry of fluid flow and heat transfer technical issues	Fall/Spring
JPL	JPL1-01-08-SU	Lunar & Planetary Surface Systems	Technologies for planetary environment monitoring	Summer 2008
JPL	JPL1-02-08-SU	Lunar & Planetary Surface Systems	Brain-Machine interfaces for hands-free applications	Summer 2008

Center	Internship #	Area	Description	Time frame
JPL	JPL1-03-08-SU	Lunar & Planetary Surface Systems	Robots that crawl, move like snakes	Summer 2008
JPL	JPL1-04-08-SU	Lunar & Planetary Surface Systems	Formation Flight	Summer 2008
JPL	JPL1-05-08-SU	Lunar & Planetary Surface Systems	Formation Flight	Summer 2008
JPL	JPL1-06-08-SU	Lunar & Planetary Surface Systems	MDF robotic platforms	Summer 2008
JPL	JPL1-07-08-SU	Lunar & Planetary Surface Systems	Electronic hardware thermal reliability	Summer 2008
JPL	JPL1-08-08-SU	Lunar & Planetary Surface Systems	Power and Sensor electronics	Summer 2008
JPL	JPL1-09-08-SU	Lunar & Planetary Surface Systems	Bio-inspired robots	Summer 2008
DFRC	DFRC4-01-08-SF	Spacecraft	Flight Abort Test Program	Summer/Fall 2008
DFRC	DFRC4-02-08-SF	Spacecraft	Flight Abort Test Program	Summer/Fall 2008
DFRC	DFRC4-03-08-SF	Spacecraft	Flight Abort Test Program	Summer/Fall 2008
DFRC	DFRC4-04-08-SF	Spacecraft	Flight Abort Test Program	Summer/Fall 2008
DFRC	DFRC4-05-08-SF	Spacecraft	Flight Abort Test Program	Summer/Fall 2008
KSC	KSC1-01-08-SP	Lunar & Planetary Surface Systems	These tasks support the Exploration Life Support Project of ESMD. They are: Water Recovery Systems (WRS) Element by characterization of the microbial communities in water processed and stored for CEV; Waste Management Systems (WMS) Element by characterization of the microbial communities in solid waste solid waste compacting, storage and safing development for CEV; Habitation Element by developing efficient, high quality lighting systems for CEV, LSAM, and surface systems, including the use of LED and direct solar light capture systems with acceptable spectrum for human vision; Air Revitalization Element (ARS) by testing (COTS) polymer adsorbents for filtering trace contaminants found	Winter

Center	Internship #	Area	Description	Time frame
			in cabin air; and developing a hypobaric test capability for assessing environmental and chemical sensors / detectors for CEV and Lunar landing applications.	
KSC	KSC1-02-08-AN	Lunar & Planetary Surface Systems	Interns would work on oxygen production from lunar regolith, characterization of lunar regolith volatiles and excavation of lunar regolith	Anytime
KSC	KSC2-03-08-AY	Ground Operations	This position will be with the KSC Constellation Project Office which is responsible for developing the infrastructure and ground operations that will allow us to explore the Solar System. An intern with an industrial engineering concentration will have the background that concentrates on the design, improvement, and installation of integrated systems of people, material, information, and equipment. These skills will be of value to the Orion Crew Exploration Vehicle processing, launch, landing, and recovery, operations concepts and requirements development. The intern will be able to glean from complex scenarios involving people, technology, and information, the major integration challenges faced by NASA to effectively implement the Vision for Space Exploration. This will be a very worthwhile learning experience and present opportunities for related projects, papers, etc.	Spring & Summer
KSC	KSC2-04-08-AY	Ground Operations	Shuttle Fluids Branch is interested in hosting interns to assist in developing spacecraft processing equipment.	Summer
KSC	KSC2-05-08-AY	Ground Operations	Software Engineer in the Application, Simulation and Support Software Branch (NE-C1) The position duties include: -Identify and work with Software Requirements, Design and Test tools. -Support refinement of existing Software Engineering Process. -Help to identify tools, methodologies, and approaches to automate the software engineering process. The incumbent may also develop requirements, concepts, designs, cost trades and schedules for the assigned tasks and provide reports and presentations as necessary. Provide software engineering in support of the Space Shuttle's Launch Processing System, Constellation's Launch Control System and other NASA/government programs. Support technology development activities for software development purposes.	

Appendix C: Approved Senior Design Projects

This was the list on August 10, 2007. Please check the website for the most recent <http://education.ksc.nasa.gov/ESMDspacegrant/>

Center	Area	Title	Description
ARC	Lunar & Planetary Surface Systems	Non-Prehensile Mobile Manipulation	NON-PREHENSILE MOBILE MANIPULATION The goal of this project is to design non-prehensile robot manipulation devices for lunar site operations, such as cable running, leveling/grading, and rock clearing. A variety of approaches are possible including pushing, tapping, or rolling. These modes of manipulation require the robot to have some understanding of the physics of interacting with a part, particularly friction and contact. In addition, robotic systems should take advantage of different strategies for manipulation, such as picking up a part by pushing it against a fixed obstacle. This project involves electrical and mechanical engineering and some embedded system (e.g., microcontroller) programming.
ARC	Lunar & Planetary Surface Systems	Real-Time Stereo Vision For Robot Navigation	REAL-TIME VISION FOR VEHICLE NAVIGATION The goal of this project is to develop a real-time computer vision library to support vehicle navigation (mobile robots, lunar transport rovers, etc). The library will allow vehicle control system developers to quickly assess the nearby environment, e.g., to determine if a particular arc is collision-free over a specified distance. This library will take advantage of real-time performance provided by a hardware-based stereo vision system (Tyx G2 camera) and include methods for processing 3D point clouds, generating grid-based occupancy/obstacle maps, and evaluating drive arcs. This project will involve computer vision theory, cross-platform software development, and testing on a mobile robot.
ARC	Lunar & Planetary Surface Systems	GeoCam: A Low-Cost Camera for Rapid Geo-Referenced Aerial Mapping	GEOCAM: A LOW-COST CAMERA FOR RAPID GEO-REFERENCED AERIAL MAPPING The goal of this project is to develop the "GeoCam", a camera system that can be used to rapidly map local areas from low-flying vehicles (small planes, lunar hoppers, etc). High-resolution digital imagery acquired from low-altitude flight can supplement wide-area coverage provided by orbiting cameras, particularly when surface features are best viewed up close or satellite task time is limited. The GeoCam will be designed to: attach easily/rapidly (while respecting operational regulations), provide high-precision pose estimates (position and pointing) for each captured image, and be as low-cost as possible. This project will involve trade studies (capture device, storage medium, etc.), mechatronic system engineering, and development of position estimation software.
ARC	Spacecraft	Small Spacecraft Design Concepts	Small spacecraft show great promise for future NASA missions. Because of their nature, these spacecraft typically have very low margins in mass, power, and propulsion. In order to make these systems viable, NASA needs evaluate what is possible with innovative concepts for microspacecraft landers, rovers, and communications relays that could be used for very low cost robotic lunar precursor missions
KSC	Ground Operations	Packetized Telemetry Converter	Utilizing reconfigurable logic devices, develop a system that accepts packetized telemetry and outputs a PCM stream compatible with IRIG-106-05 Ch.4 for input to existing ground based telemetry processors. The intent of this project is to

Center	Area	Title	Description
			determine whether existing KSC telemetry processing devices can be utilized in the Constellation packet telemetry environment or if all the PCM based devices need to be replaced. The use of FPGA type devices provides the flexibility to update the translation routines without requiring hardware change-out.
KSC	Lunar & Planetary Surface Systems	Senior Biological Engineer	NASA Exploration Senior Design Project: Habitat Module Components, Subsystems and Systems The goal of this senior design project is the design, integration, and evaluation of components, subsystems, and systems of a prototype habitat module. NASA could then validate and test concepts for the ultimate design of a "Surface Habitat Module" to be used on the Moon or Mars. The focus will be on the design of components, subsystems, and systems to reduce resupply of life support elements (i.e., air, water, and food), and incrementally evolve and integrate current resupply methods and physical-chemical technologies with bioregenerative technologies. This project should emphasize the critical system selection criteria of minimum launch mass, efficient utilization of volume and power, and minimization of crew labor time and lifecycle costs. The minimum design elements to be considered include: structures, automation and mechanization (robotic manipulators), sensors, command/control and data handling, and power. The habitat subsystems will consist of plant-based food production and processing, integrated biological processors for liquid and solid waste streams, systems monitoring with steady state and predictive control, and mass transfer interfaces for each subsystem utilizing NASA standard human life support (food, air, water and waste) input/output streams. Reliability of the mechanical and biological elements should be considered in the component design, and elements selected should be adaptable for remote, automated/semi-automated operation. Each dynamic subsystem should be mechanized where possible and incorporate configurations that accommodate expansion and integration of the habitat life support system. Incremental infrastructure developments should be integrated into all system element designs. The system must be able to identify abnormal operations and reconfigure to normal operations without human intervention. *Additional details for this project available by contacting Susan Sawyer at: Susan.G.Sawyer@nasa.gov
KSC	Lunar & Planetary Surface Systems	Lunar Regolith Processing Challenges for Oxygen Production	KT-D has been a member of a multi-center NASA project team to develop and experiment to go into the permanently shadowed craters of the lunar poles to make a determination on the quantity and form of hydrogen seen from orbit. In the first year, KSC ran a University Competition on the topic of ISRU and allowed Senior-level design teams from across the country to compete to propose a design solution to a portion of this problem. ISRU has a multitude of technical challenges that would fit nicely into this Senior Design realm, from Reaction Chamber Seals, Regolith Transfer, Regolith Excavation, Regolith Reduction for Oxygen Production, etc.
KSC	Ground Operations	Simulation-based Product Realization	NASA supports simulation for life-cycle activities: planning, design, analysis, test, check-out operations, review and training. Consciously maturing an imagined workable idea through

Center	Area	Title	Description
			framing it to optimization, building, testing and realizing the product—using simulation throughout— provides us with an important approach to innovation and project success. Each step provides increasingly exact information about the: what, who, where, when, why and how -- costs, schedules, skills, tools, systems and other needed information. *Additional details for this project available by contacting Susan Sawyer at: Susan.G.Sawyer@nasa.gov
KSC	Lunar & Planetary Surface Systems	Lunar Regolith Excavation for Oxygen Production and Outpost Emplacement	The feedstock required for O2 production on the moon is Lunar Regolith (soil). 100 metric tonnes (MT) of Lunar Regolith will be required each year for Oxygen Production of 1 MT. In addition up to 2,000 MT of regolith excavation will be required per year in the initial stages of Outpost construction. This project will investigate concepts for Lunar Regolith excavation equipment and propose solutions in the form of completed designs and prototypes.
KSC	Lunar & Planetary Surface Systems	Lunar Operations Cryogenics Consumables Transfer	Oxygen that is produced on the moon must be transferred to the end user. In addition there will be residual propellants on the descent stage that can be scavenged and re-used as valuable commodities. This project will identify methods for cryogenics consumables transfer and appropriate dust tolerant interfaces.
KSC	Spacecraft	Development of a Suborbital Experiment Platform Rack	If this IPP project is approved by NASA HQ, in the mid-08 or 09 timeframe there will be an opportunity for an engineering design class to participate in development of this rack for suborbital experiments (2-5 minutes micro-g).
KSC	Ground Operations	Innovative uses of ESMD's Distributed Observer Network (DON) for education & other NASA purposes	Form a multidisciplinary team to interface with KSC intern to test and evaluate other uses of DON and provide results in oral and written form
KSC	Ground Operations	Simulation that Supports Synthesis	Determine simulation tools/techniques that will assist engineers to work more efficiently during test and evaluation.
JSC internships and SD projects are contingent on project funding, mentor availability and management approval.			
JSC	Spacecraft	CEV Exercise	This is a request for Senior Engineering Design projects related to the design and development of exercise hardware systems for the Constellation Program based on the current resource specifications and spacecraft constraints allotted to this function. This system must be capable of providing on-orbit exercise that mitigates deconditioning effects related to space flight to preserve crew health, performance and safety. Generally, astronauts experience space-induced deconditioning that progressively worsens as mission durations lengthen. Historically, in-flight exercise has provided a holistic approach to sustain crew health and performance. The NASA Exercise Countermeasures Project (ECP) is seeking unique and imaginative systems that are capable of preserving aerobic capacity, skeletal muscle strength/endurance, neuro-sensory condition, and bone health. JSC ECP Exercise Physiologists and Engineers will be available to provide detailed information and guidance regarding space physiology and/or the spacecraft constraints.

Center	Area	Title	Description
			The goal for the project is to identify concepts and designs for an exercise device to be used in the Crew Exploration Vehicle (CEV) and/or Lunar Surface Access Module (LSAM) during lunar missions greater than 8 days in duration. The exercise device may be portable such that one device is moved from the CEV to LSAM and back to the CEV for availability during the entire mission (versus provision of multiple devices for various mission phases). *Additional details for this project available by contacting Susan Sawyer at: Susan.G.Sawyer@nasa.gov
JSC	Lunar & Planetary Surface Systems	Advanced Airlock and Dust Mitigating System (EC Pr #1)	Design of a minimum gas loss and low power EVA airlock that provides quick exit and entry for space- suited crewmembers and provides dust mitigation capabilities. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future airlock that can accommodate one or two crew members. This airlock would be an element of a future planetary lander, or human pressurized rover. The goal would be to minimize the gas that is lost during depressurization by creatively designing the layout and the operation of the inner and outer airlock hatches. Pumps to recover the gas are very heavy and require a large amount of power; therefore, they are not part of this design. The Advanced EVA Technology Group will provide information on the current airlock on the Space Shuttle, the International Space Station, and some concepts from previous studies. Small models of advanced airlocks that have been proposed could also be provided. High level design requirements for airlocks from NASA design standards would also be provided.
JSC	Lunar & Planetary Surface Systems	Advanced Lunar Pressurized Rover (EC Priority #2)	Design of a 2-4 person rover for lunar exploration with both robotic manipulator capability and EVA capability. Rover would include minimum gas loss and low power EVA airlock and dust mitigation capabilities. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future lunar pressurized rover that can accommodate 2-4 crew members. This rover would be an element of a future planetary lander. The goal would be to perform surface exploration by creatively designing the layout and the operation of the pressurized rover. The Advanced EVA Technology Group will provide information on concepts from previous studies. Small models of advanced airlocks for rovers that have been proposed could also be provided. High level design requirements for Rovers and airlocks from NASA design standards would also be provided.
JSC	Lunar & Planetary Surface Systems	Lunar Lander Large Cargo Unloading System (EC Pr #3)	Design of a robotic/EVA assisted system to unload and move large cargo/modules from a lunar lander. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future lunar lander large cargo unloading system that can robotically or EVA assisted robotically unload and position cargo and modules. This large cargo handling system would be an element of a future planetary Lander. The goal would be to minimize the overall, mass and weight of a lunar lander large cargo handling system. The Advanced EVA Technology Group will provide information on the previous designs of large cargo handling systems and some concepts from previous studies.
JSC	Lunar &	Lunar Lander EVA	Design of a system for routinely and safely transporting the EVA

Center	Area	Title	Description
	Planetary Surface Systems	Crew and Small Cargo Lifting System (EC Pr #4)	crew and small cargo up and down from the airlock to the surface and back, including innovative ladder designs and lifts. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future lunar lander EVA crew and small cargo lifting system. This EVA crew and small cargo lifting system would be an element of a future planetary Lander. The goal would be to minimize the overall, mass and weight of a lunar lander crew and small cargo lifting system. The Advanced EVA Technology Group will provide information on the previous designs of crew ladders and some concepts from previous studies.
JSC	Spacecraft	Flight Demonstration of Autonomous Rendezvous & Docking	The Aeroscience and Flight Mechanics Division at the Johnson Space Center is responsible for the development of technologies required to conduct rendezvous and proximity operations in space in support of the President's Vision for Exploration. A major element of this vision is the ability for two spacecraft to autonomously rendezvous and dock (AR&D) in space. Since the United States space program has never demonstrated this capability, it is the purpose of this University Design Project for two universities - the University of Texas and Texas A&M University - to each build a satellite (currently each university is allocated one half of a pico-satellite) that will ultimately rendezvous and dock with each other in space without the benefit of human intervention. While this would be a good design project for any university spacecraft design class, the innovation that makes this project much more significant is that it requires the actual fabrication of flight hardware that will be launched into space. In addition, it involves two flagship universities, and requires them to work together to solve the many problems they will face as they independently build two spacecraft that will be required to communicate and mechanically interface in order to successfully rendezvous and dock in space. This provides a tremendous opportunity for students to learn the art of project management. *Additional details for this project available by contacting Susan Sawyer at: Susan.G.Sawyer@nasa.gov
JSC	Lunar & Planetary Surface Systems	Planetary EVA Suit Fuel Cell	Design a complete 1kW fuel cell powerplant for EVA suit applications. Design should optimize on specific power and system specific energy within the constraints of a defined operational life and duty cycle. Project includes selection of electrolyte chemistry, membrane electrode assembly design, and fuel cell accessory section.
JSC	Lunar & Planetary Surface Systems	Remote Image System Acquisition (RISA) - Space Camera 4 (SC4) Development	The purpose of the RISA SC4 project is to produce a high quality / high reliability wireless imager designed specifically for the space environment. The imager will be used to monitor the health and status of the crew and vehicle as well as used on Lunar and Martian surfaces. The SC4 design will be based on the existing SC3 and SC2 imagers.
JSC	Lunar & Planetary Surface Systems	Remote Image System Acquisition (RISA) - Multispectral Imaging	The purpose of the RISA Multispectral Imaging project is to develop methods to use multispectral imaging for materials identification, locating vegetation, atmospheric penetration, and improving methods to identify properties of interest to the NASA mission to meet exploration objectives.
JSC	Lunar & Planetary Surface Systems	(Five projects) Software Defined Radio (SDR) Project	(5 projects) Design various components (VGA and keyboard Interface in VHDL, VHDL debugger/logic analyzer, Audio Module, RF Board, USB interface, Ethernet Layer) for the Software Defined radio(SDR) Project. Projects may involve one

Center	Area	Title	Description
			or more of these sub-areas.
JSC	Lunar & Planetary Surface Systems	Hand -Held Magnetic Lunar Dust Removal Brush	Since most of the lunar dust is magnetic, a brush with magnetic bristles could be designed to brush the space suit or any other items and the dust would be attracted to it. If the brush was electromagnetic or mechanical where the polarity could be changed, then the poles could be reversed and the dust would be repelled and dropped to the surface after use.
JSC	Lunar & Planetary Surface Systems	Peel -Off Space Suit Visor Protective Film	Since the space suit visor will be scratched and get dust after each EVA, design a peel-off film or coating that can periodically be removed so the astronaut can clearly see and not have scratches, especially during long duration missions.
JSC	Lunar & Planetary Surface Systems	Dust Tolerant Hand Tools	Standard tools, such as ratchets, folding handles on tools, and extendable devices, such as tripods will be used during lunar assemble, maintenance, and science tasks. Design some typical tools, such as a folding handle or ratchet, that has mechanisms that are extremely robust and dust tolerant.
JSC	Lunar & Planetary Surface Systems	Lunar Lander Dust Mat	Since there will much walking at the base of the lander, especially around the airlock, design a lunar mat so the astronauts are not walking constantly in the lunar dust. This may sound simple, but the requirements are: light weight, low volume when stowed, easily deployed, dust can be removed or falls between mesh. The crewmembers would prepare sample boxes, repair equipment, and dust off on this mesh prior to entering the airlock.
JSC	Spacecraft	Microphone Beamforming Array Estimation Model	Develop a beamforming microphone array model and compare against an actual microphone array measured data. This model would help predict microphone array configuration performance. The model would be developed in MatLab that would help determine the theoretical lower bound of performance using the Cramer-Rao lower bound method. An actual microphone array is built and data gathered and compared against the theoretical model. This project has potential applicability in the Constellation program CEV, lunar lander, and EVA spacesuit where a crew-worn headset is not necessary.
JSC	Spacecraft	A Field Programmable Analog Array (FPAA) Voice Activated Switch (VOX)	Develop a VOX device through the use of FPAA devices. Investigate the feasibility of using FPAA for simplifying the attack and decay time adjustments of the VOX through the use of digital techniques. This has applicability in the constellation program for not only for the audio systems but also understanding FPAA technology in use for other constellation systems. A circuit will be developed and data gathered to understand the performance of the VOX circuit. A process for implementing FPAA circuits will also be written.
JSC	Lunar & Planetary Surface Systems	Design of a Wireless Sensor Scavenging Network	Design a wireless sensor energy scavenging network that provides communications to a base station (mobile or stationary) from an array of intelligent sensors nodes comprised of various transducers, sensors, RF transmitters/receivers and controllers with their own power source that does not require batteries to operate. The wireless network sensors obtain power from the environment (power harvesting) and would respond to an interrogation command from the base station to send their data acquisition data to the base station. The wireless sensor scavenging network is programmable for sending data on demand or periodically. In addition, the sensor network can be reconfigured to acquire different types of data from each sensor by the base station. This has applicability for the lunar and

Center	Area	Title	Description
			beyond outposts. Design includes what trades were made to arrive at the design and concept of operations.
JSC	Propulsion	Electric Propulsion Systems	Investigate new forms of electric propulsion that can be used for future exploration objectives. Build prototypes of existing methods of electric propulsion and compare them to alternate methods developed under this effort.
GSFC	Lunar & Planetary Surface Systems	Design of a Spacecraft to support a Lunar Mission	Engineers would give the students a set of instruments and a lunar orbit and let them design the spacecraft to support the mission. This project would be suitable for a class where the student already knows something of designing spacecraft.
GSFC	Lunar & Planetary Surface Systems	Thermal Control System (TCS) for Lunar (or Mars) Rovers	For future rovers a robust, simple, lightweight thermal control system will be required. The conventional thermal architecture uses a pumped fluid loop and was used on Mars Pathfinder and Mars Exploration Rover (MER). An alternative system using a miniature loop heat pipe (LHP) system has been proposed, which is an order of magnitude lighter, less costly and has no moving parts. The students will be asked to perform trade studies on this and other possible solutions, taking into account weight, reliability, cost, ease of integration etc, as part of their approach. They will be asked to determine the environment and perform thermal analysis to show that temperature limits have not been exceeded during 1) interplanetary cruise 2) descent and landing 3) surface operations. Mechanical or CAD drawings will be developed to show how the system will be integrated into a typical rover concept, such as Pathfinder or MER as well as how the TCS interfaces with other supporting sub-systems such as Power and C&DH.
GSFC	Lunar & Planetary Surface Systems	Design of Helium-3 Mining Equipment for the Moon	Dr. Harrison Schmitt (Apollo-17) has just published a new book, "Return to the Moon". This book is a detailed technical study of the commercial possibilities of mining He-3 on the Moon to meet the energy crisis on Earth. The technical detail of Dr. Schmitt's study is most impressive, and it does have a few additional areas that could be addressed by a student design project. The technical detail of Dr. Schmitt's study is most impressive, and it does have a few additional areas that could be addressed by a student design project. One of these areas is the processing of Lunar regolith to extract the volatiles. This will involve the digging of extremely gritty material, screening it, moving it, heating to 700 C, sequestering the volatiles, and discharging it. All this must be done in the Lunar environment using extremely reliable equipment with very long useful lifetimes that is solar powered and can be easily maintained by a combination of a few astronauts and robots controlled from Earth. No mean task. The key problem of sequestering the volatiles and the maintenance problems associated with machines that handle gritty material, like chicken feed, are topics for investigation. I would like to suggest a new study of design of a Lunar He-3 miner that shows clear respect for the Lunar environment, treats each individual gas molecule and microscopic dust particle as an independent entity, models their movement as a particle migration, is reliable, and addresses the problems of handling lunar grit. The problem would be to detail a full scale miner and then engineer it down to a small rover that could actually be sent to the Moon and test the key concepts of the larger design.
GSFC	Spacecraft	Exploration	Engineering students would be provided with the current ESAS

Center	Area	Title	Description
		Systems Architectural Study Mission Design	documents and evaluate the current strategy and provide recommendations.
GSFC	Spacecraft	SuitSat Follow on	Engineering students will provide recommendations designs of instruments on SuitSat follow on that are in alignment with Exploration goals and objectives, for example a radiation shielding or monitoring experiment. http://science.nasa.gov/headlines/y2006/26jan_suitsat.htm
GSFC	Ground Operations	Use of a Fabry-Perot interferometer for precise column carbon dioxide measurements and monitoring.	Use existing Fabry-Perot Interferometer to make daily-long term measurements of CO2 column; check calibration/stability of instrument and evaluate data.
GSFC	Ground Operations	Embedded Science Data Processing Applications Using High-Performance Hybrid Platforms	Work on a robotic path planning demonstration; R&D involving SAR and Hyper-spectral data processing; and robust software architecture that will help fly commercial processors reliably in a space-radiation environment. Students need to have C and/or VHDL experience, and combined hardware/software experience.
GSFC	Lunar & Planetary Surface Systems	Lunar Terrain Categorization	Surface mission operational planning has been identified as one area of special interest within the Scientific Context of the Moon Exploration. Specifically, technologies that will enable scientists to perform terrain categorization, and in particular to detect, identify and characterize rocks, will be studied. Once lunar data is geo-registered & mosaiced to a common Lunar Geodetic Grid, these tools will assist scientists in determining general regions of interest, in performing precise targeting of specific types of samples, & in avoiding hazardous landing sites. Regions of interest will mainly be determined by understanding and characterizing potential lunar resources (minerals, ice, etc.) and their spatial distribution, their abundance, density, and distribution, relative to future missions and in-situ instruments that will be needed to perform additional detailed analyses. Rock identification will play an essential role in targeting specific samples, and rock location and distribution will be essential for selecting landing sites while avoiding hazards. Another important tool in selecting landing sites will be to accurately compute slopes and surface roughness parameters, from laser altimeter or stereo data, taking into account appropriate solar illumination models. Specifically, the work will focus on terrain classification and SAR data hazard analysis.
GRC	Lunar & Planetary Surface Systems	Ray Domes for Lunar Surface Communication Devices	Under the Constellation mission, a permanent base will be settled on the lunar surface for exploration. Various communication devices such as Lunar Communication Terminals (LCT) will be installed on the moon surface. The goal of this project is to design a ray dome protecting communication devices and build a scale model of it. The ray dome protects communication devices from accumulating moon dust and flying moon dust particles generated by the thrust from the Lunar Surface Access Module (LSAM). The flying particles reach the speed as high as 2 km/sec. The ray dome should be foldable or collapsible for easy transportation and installation. It must also

Center	Area	Title	Description
			withstand the harsh moon environment including the extreme temperature variation in the range of 100 to 420 K.
GRC	Lunar & Planetary Surface Systems	User Friendly Body Attachment Gears for Health Diagnoses	Vision Research and Human Health Diagnostics Laboratory at GRC conducts research on diagnosing human health non-invasively through countermeasures using eye and skin as a window to the body. The objective of this project is to develop user friendly body attachment gears with health monitoring sensors and probes. One particular example of such body attachment gears is a helmet equipped with oximeter probes and possibly with dynamic light scattering and corneal topographer eye examining probes. For more information about the lab visit the following web site: http://exploration.grc.nasa.gov/grcbio/VisionResearch
GRC	Lunar & Planetary Surface Systems	Mechanical Components and Simulations for Modular Mobility Test Demonstration (MMTD) vehicle	At GRC, a wide range of mechanical systems for the next generation lunar rover are developed and tested through the test vehicle called Modular Mobility Test Demonstration (MMTD) vehicle. The Simulated Lunar OPERATION (SLOPE) facility provides the MMTD a test environment of a simulated lunar surface terrain with up to 45 degrees of inclination. Some of important mechanical issues include terramechanics (the study of interactions between vehicle wheels and various terrains specifically the simulated lunar surface), drive train, and suspension. Senior design project opportunities are available for designing and fabricating mechanical components, developing wheel/soil interaction models, etc.
GRC	Lunar & Planetary Surface Systems	Lunar Surface Mobility	This senior design project opportunity is for considering many different forms of lunar surface transportations depending on specific mobility needs. These include for example how to effectively and reliably carry an object of up to 10 metric tons from a landing site of a Lunar Surface Access Module (LSAM) to a habitat and how to move an object in and out of a moon crater. Creative out of box thinking which is not constrained with regular wheeled type vehicles is encouraged.
GRC	Lunar & Planetary Surface Systems	Battery Packaging for Astronaut's Suit	The goal of this project is to develop a packaging method of Lithium-Ion batteries for an astronaut's suit. The packaging must allow full mobility of an astronaut and easy recharging. It must also be equipped with an appropriate thermal protection and cooling system to maintain the battery operation temperature in the range of -60 C to +60 C.
GRC	Propulsion	Mechanical Components for Cryogenic Tank	Cryogenic propellant tanks, such as those used for the Lunar Lander, are rather complex systems with many electro-mechanical components for fuel supply, thermal control, pressure control, and low gravity propellant gauging. The objective of this senior design project opportunity is to consider the operability and reliability of those mechanisms inside or connected to the tank where the operating temperature range is extremely large. Thermal expansion of mechanical components, materials to withstand thermal cycles, sizes and weights of the mechanisms are some of important considerations.
JPL	Lunar & Planetary Surface Systems	Intelligent Hardware/ Software Integrated Technologies for 360 Degree Vision	Developing robotic vehicles with advanced vision guided tools for planetary exploration and in Habitats
JPL	Lunar &	Brain-Machine	Develop real-time interfaces between humans and machines by

Center	Area	Title	Description
	Planetary Surface Systems	Interfaces	processing brainwaves to perform robotic operations
JPL	Lunar & Planetary Surface Systems	Human-Robot Interfaces	A project would be to develop a new tool for inspection and particle removal based on something such as pediatric surgical instruments. The project would be successful if 1) you could control a very long borescope instrument through a tube that has several bends and is several feet long. The insertion point would be very small. 2) you could successfully view and remove a particle the diameter of a mechanical pencil lead.
JPL	Lunar & Planetary Surface Systems	Modeling and Simulation	Develop modeling and simulation platforms for training humans in planetary exploration
JPL	Lunar & Planetary Surface Systems	High-Level and/or Goal-Based Commanding of Robots	Human gesture recognition and other cue-based command recognition systems
JPL	Lunar & Planetary Surface Systems	Sensor-Based Command Execution	Develop self-controlling approaches to execute sensor-based commands
JPL	Lunar & Planetary Surface Systems	Command and Sequence Verification	Develop approaches to verify command and control generated by either human or sensor-generated inputs
JPL	Lunar & Planetary Surface Systems	Performance Accountability and Intent Compliance	Develop reliable approaches to guarantee task performance
JPL	Lunar & Planetary Surface Systems	Self-Operating and Self-Regulating Power Systems	Develop intelligent monitoring and diagnostic systems for monitoring the health of power systems
JPL	Lunar & Planetary Surface Systems	Robotic Platform Concepts for Lunar Mining Operations	Develop robotic platforms for mining operations and end-to-end processing systems
JPL	Lunar & Planetary Surface Systems	Processing And Extraction of Life Supporting Elements from Surface and Subsurface Materials	Develop architectures and approaches to extract life-supporting elements from planetary materials
JPL	Lunar & Planetary Surface Systems	Concepts and Framework for Planetary and Interplanetary Transportation Systems	Develop innovative approaches to transportation mechanisms on planetary systems
JPL	Lunar & Planetary Surface Systems	Hierarchical Control Architectures for Large-Scale Habitat Monitoring	Develop reliable architectures for monitoring the environment within habitats

Center	Area	Title	Description
JPL	Lunar & Planetary Surface Systems	Habitat Design Concepts	Develop practical architectures for habitats
JPL	Lunar & Planetary Surface Systems	Concepts for Robotic Construction Machinery	Develop concepts for robots used in habitat construction (collaborating robots)
JPL	Lunar & Planetary Surface Systems	Advanced Concepts for Cliff-Climbing Robots	Develop robots that can climb cliffs
JPL	Lunar & Planetary Surface Systems	Formation Flight Systems – Navigation, Guidance, and Control	Develop approaches for formation flight involving a swarm of aerial robotic platforms
JPL	Lunar & Planetary Surface Systems	Telerobotics	Develop concepts and approaches for telerobotic applications in medicine, mining, and other exploration related missions
JPL	Lunar & Planetary Surface Systems	Amphibious Robots	Develop robots that can perform amphibious operations autonomously
JPL	Lunar & Planetary Surface Systems	Self-Organizing Mobile Ad-Hoc Networking	Develop robust approaches to self-organizing in mobile and fixed sensor networks
JPL	Lunar & Planetary Surface Systems	Robots for Gas Pipeline Leak Detection	Develop robots for leak detection in gas pipelines
JPL	Lunar & Planetary Surface Systems	Self-Verification Systems	Develop reliable approaches to ensure safety and reliability of systems and subsystems through self-monitoring, self-diagnostic, and self-repair mechanisms
JPL	Lunar & Planetary Surface Systems	Planetary Transportation Systems	Concepts and framework for planetary and interplanetary transportation systems
JPL	Lunar & Planetary Surface Systems	Radiation Protection and Mitigating Effects	Develop approaches to detect radiation hazards and provide rapid mitigation
JPL	Lunar & Planetary Surface Systems	Self-Protecting Systems	Develop concepts and architectures for self-protection against planetary hazards and harsh environments
JPL	Lunar & Planetary Surface Systems	360 degree Vision System	Planetary exploration requires various types of sensing systems to observe the environment. In harsh surface environments, there is a need to build underground habitats where sensors from the habitat can "peek" above ground to rapidly obtain a 360 degree view of the surface conditions. The sampling times can vary between very short durations to long durations depending upon the surface conditions. A typical example could be viewing

Center	Area	Title	Description
			dust storms on Mars where the probe would be used for just a few seconds to protect the sensing elements from damage.
MSFC	Spacecraft	Design for Reliability and Safety	Safety and Reliability is a top priority for NASA in the development of new launch systems. There is a need to define and develop a process that describes how to "design for reliability and safety". This is a system engineering design project that addresses all what needs to be done throughout all the phase of a program (quantitative and qualitative) to design highly reliable and safe launch systems. This includes identification of products, tools, approaches, etc. by program phase.
MSFC		Implementing a Fully Integrated Digital Design-to-Manufacturing Environment	Opportunities for participation will include: • Digital manufacturing • Generation and translation of CAD models between distinct environments • Development of virtual environment for development and production facilities, trade studies and facility limitation/impacts • Simulations and manufacturing process development, and coordinated motions programming and controls • Modeling/reverse engineering on exiting tools and hardware • Validation of assembly sequences and related human factors operations • Manufacturing process optimization • Validation of assembly and flight hardware transportation
MSFC	Lunar & Planetary Surface Systems	In-Situ Resource Utilization (ISRU)	In-Situ Resource Utilization (ISRU) is often described as "living off the land", but the "land" happens to be the Moon or Mars. ISRU provides a fertile training ground for the next generation of scientists and engineers. Any practical ISRU devices will draw on a wide range of engineering disciplines including chemical, mechanical, electrical, systems engineering and applied physics. Successful senior design teams often require just this type of mixture. Marshall Space Flight Center has been active in the area of ISRU oxygen production from both Lunar and Martian resources. Oxygen is clearly important for both life support and propellant production. Lunar regolith contains oxides that can be separated by molten oxide electrolysis (MOE). This technique can produce oxygen, silicon and a variety of metals. The Martian atmosphere consists mainly of carbon dioxide. Thus, a great deal of oxygen is available on Mars if one can break the chemical bonds. This can be accomplished thermally or by using radio frequency (R.F.) plasmas. These methods of oxygen production (Lunar and Martian) have been demonstrated in the laboratory, and need to be engineered into practical devices. Engineering design criteria must include the oxygen production rate, power consumption, energy sources, reliability and the cost of transporting terrestrial consumables. Designs may be autonomous or require human interaction.
MSFC	Lunar & Planetary Surface Systems	Lunar Surface Habitat Thermal Control System Design	With diurnal temperature variations between -270°F and +240°F, designing for habitation on the lunar surface presents many challenging problems. This project will consider the design of a habitat (or vehicle) thermal control system to provide a shirt sleeve environment for crew and equipment inside of long duration lunar outpost.
MSFC	Lunar &	Optical Techniques	Optical correlation techniques are currently being investigated

Center	Area	Title	Description
	Planetary Surface Systems	for Guidance and Navigation During Landing	for unmanned vehicle to international space station robot docking. Early results indicate that the technique is robust and matches well with the current 3-D rendering software now available. The technique could be applied equally well to landing by unmanned vehicles at a site that has either been mapped well or that has been mapped sparsely and can be rendered in 3-D. The optical correlation technique has been well characterized in the past and is now finding its way into many applications.
MSFC	Lunar & Planetary Surface Systems	Lunar Precursor Robotics Program	Mobility systems are needed to identify and characterize the resources available on the lunar surface. Specifically, large craters at the lunar poles. Rover designs capable of navigating in near complete darkness, obtaining the required number of samples, and surviving 50K temperatures are an extreme challenge. The design team would be tasked to investigate various low light vision systems for telerobotic operation and combinations of power and thermal control systems to operate in the dark and in sunlit conditions.
MSFC	Propulsion	Nuclear Fission Surface Power Design	This project will focus on the design and potential utilization of a 20–40 kW Fission Surface Power System for use anywhere on the surface of the moon or Mars. The project will include performing a top level design of the Fission Surface Power System, including the reactor, shield, power conversion, power management and distribution, and radiator. Potential uses of the electrical or thermal energy from the reactor should be identified. Methods for emplacing and deploying the system should also be discussed. Emphasis should be on systems that minimize programmatic risk and utilize well proven technologies.
MSFC	Lunar & Planetary Surface Systems	Radiation Effects on Electronics Modeling	Develop advanced models of the natural radiation environment to diagnose and predict the effects of Single Event Effects (SEEs) on modern electronic architectures.
MSFC	Lunar & Planetary Surface Systems	Reconfigurable Computers	Provide reconfigurable computing capability, resulting in reduction of flight spares and risk reduction for limited circuit lifetimes.
MSFC	Lunar & Planetary Surface Systems	Integration of Surface Mobility Systems through Systems Engineering	Designing and building surface mobility mechatronics systems by multi-disciplinary teams. Not only the design of such systems but also the process of developing the entire system will be emphasized.
MSFC	Lunar & Planetary Surface Systems	Autonomous Object Detection and Avoidance	Real-time autonomous object detection and avoidance for lunar rover and autonomous lander
MSFC	Lunar & Planetary Surface Systems	Autonomous Vehicle System Failure Detection and Response	Development of computer algorithm to Autonomously detect vehicle system failures and intelligently making countermeasures against such failures
MSFC	Propulsion	Liquid Engine System Performance Modeling	Liquid engine system performance modeling & main propulsion system analysis. Includes current liquid rocket engines and future new & derivative engine analysis & predictions
MSFC	Lunar & Planetary Surface	Lunar ISRU and Solar Energy	Design self-support system for the Lunar outpost using lunar material and solar energy.

Center	Area	Title	Description
	Systems		
MSFC	Lunar & Planetary Surface Systems	Planetary Instrument Sample Collection Device	Marshall Space Flight Center has been developing a miniaturized Scanning Electron Microscope for in situ imaging and chemical mapping of samples for use on the Moon (as well as other planetary bodies.) This project would require the mechanical design and prototyping of a sample collection scheme that would take samples from the lunar surface and introduce them into a sample chamber for analysis. A fully automated sample collection device would allow for the instrument to be operated remotely from a rover. Some key considerations instrumental to this design are dust mitigation, selectable sample size, temperature fluctuations on the lunar surface, and compactness of design.
MSFC		General purpose heat source simulating a radio-active heat source	A compact size radio-active heat source is considered for many heating applications for space exploration including temperature control of various mechanical and electrical components under a cryogenic environment on the moon surface. The objective of this project is to develop a general purpose heat source which simulate the conditions of the radio-active heat source so that experiments can be done in safe and cost-effective manners
	Propulsion		
MSFC		Diagnostics for plasma propulsion systems	Plasma thrusters are spacecraft propulsion devices that expel their propellant at a much greater velocity than chemical rockets. Consequently, they require less propellant to complete a given mission, leaving more room on a spacecraft for hardware/consumables/instruments. There is a need to have diagnostics that can measure the time-varying plasma properties in such thrusters to validate the present theoretical understanding of such devices and to serve as experimental benchmarks that can support the development of numerical models. Senior project opportunities are available in designing and constructing robust, stand-alone diagnostic packages with plug-n-play capability for use with many thruster types and in designing and fabricating experiments for evaluation of new diagnostic techniques.
	Propulsion		
MSFC		Liquid metal system components for nuclear surface power	There is presently an effort underway at MSFC to evaluate components that might be included in the design and eventual deployment of space and lunar-based nuclear reactor systems. The evaluation effort involves the use of a simulated nuclear reactor core (comprised of resistive heating elements) where pumped NaK (sodium-potassium eutectic) is used as the heat-transfer medium. In these systems there is significant need for improvement over present state-of-the-art component technology. This includes the need for lighter-weight, more efficient liquid metal pumps, more accurate flow rate measurement techniques, and capabilities to monitor the state of the liquid metal (liquid level, temperature, etc), especially in locations that are not easily accessible. Senior projects would aim at evaluating different strategies to improve technology over the present state-of-the-art through a combination of literature research, theoretical and numerical modeling, performance analysis, fabrication and testing.
	Propulsion		
MSFC		ROCETS (Rocket Engine Transient Simulation) Improvements	ROCETS (Rocket Engine Transient Simulation) is MSFC's in-house tool of choice for modeling a complete rocket engine system. ROCETS use at MSFC has primarily been in steady-state and transient analysis of proposed rocket engine designs. The code is FORTRAN based and very flexible, however, it
	Propulsion		

Center	Area	Title	Description
			lacks user friendliness and has a rather steep learning curve. Past efforts undertaken to enhance ROCETS capabilities have focused on usability and modeling ease. One effort worthy of note has been the GCOMB (Generalized COMBustion) effort that has significantly simplified modeling transient mixtures of fluids such as that occur during purging and priming of rocket engine manifolds. The effort currently being proposed is to complete development of the integrated design tool based on ROCETS. The effort will be composed of three major efforts. First, the optimization scheme previously developed for ROCETS will be refined and made more robust. Second, design modules will be developed for rocket engine pumps, turbines, and combustion devices. Third, existing rocket engine component modules will be refined. (Each of these efforts could be a separate senior design project.)
MSFC	Propulsion	Crew launch vehicle propulsion system	Crew launch vehicle propulsion system design, development, test, and evaluation
MSFC			After shuttle launches, there have been numerous occasions where we need to perform inspections on hardware while still in a system configuration. Most of the time the inspection port may be several feet from the part we would like to inspect such as a filter or screen. The path to that port will most likely pass through several bends. Typically, we are looking for small particles of debris that are thousands of microns - roughly the diameter of mechanical pencil lead. When we see these types of particles and they are in a critical area, we would like to remove them. We have borescopes, which include tiny lights and cameras, which we use to try and view these particles. We also have tiny vacuums that we use to try to remove the particles. The borescope lighting is relatively poor so the camera picture is also not of the best quality especially when you are trying to identify the type of particle that is in the system. The vacuum doesn't always work because of poor suction caused by its small size. Many times we fly hardware with debris that we prefer to remove if we could. We would like to develop new tools to enable us to better perform these tasks. There are pediatric surgical instruments that have many of the qualities we like but not the desired length.
	Propulsion	Shuttle Propulsion Systems	
MSFC	Lunar & Planetary Surface Systems	NASA X-TOOLSS (eXploration Toolset for Optimization Of Launch and Space Systems)	Description: Use of the NASA X-TOOLSS software for design optimization of conceptual space systems. NASA X-TOOLSS is based on genetic and evolutionary algorithms, which have proven successful for global optimization of complex systems, and for applications where unique and innovative designs are sought. An advantage of NASA X-TOOLSS and genetic/evolutionary optimization is that the design space is not limited to existing designs and approaches. Example applications of interest for NASA X-TOOLSS include habitats for the Moon and Mars, lunar surface mobility and power systems, lunar descent module and lander concepts, and thermal/structural design of small satellites and other spaceflight hardware.

Center	Area	Title	Description
HQ	Lunar & Planetary Surface Systems	Medical Diagnostics	What Medical Diagnostics, Monitoring and Treatment Tools can/should be provided for Explorers? Astronaut explorers will be far from home and will need to have capabilities for medical care that are independent of Earth.
HQ	Lunar & Planetary Surface Systems	Counter-measures to Combat the Negative Effects of Spaceflight on Humans	What are the best countermeasures to combat the negative effects of spaceflight on humans? In the absence of body loading and contact forces that are present on Earth, muscles, bones and the heart atrophy, and fluid-electrolyte systems are disrupted.
HQ	Lunar & Planetary Surface Systems	Informatics and Information	How can Informatics and information capture best be done and utilized rapidly in problem solving?
HQ	Lunar & Planetary Surface Systems	Tools, Techniques and Technologies Designed to Facilitate Human-Machine Interactions	What kind of tools, Techniques/Technologies can be designed to Facilitate Human-Machine Interactions? What solutions can be engineered to maximize human explorers' health and productivity in weightlessness?
LaRC	Lunar & Planetary Surface Systems	Design & integration of a robotic platform for science instrument testing	Analysis of multi-input/multi-output control systems, designing power systems, robotic autonomy algorithms, stereo visualization software architectures, instrument data integration schemes, performing electromagnetic interference tests, & programming data processing algorithms in National Instrument's LabVIEW software. Current effort covers major aspects relating to mechanical hardware design & construction, sensors system integration, algorithmic data product integration, motion control system design, & implementation of an algorithm development framework. Future effort will be heavily algorithmic and software oriented.
LaRC	Lunar & Planetary Surface Systems	Rover-Electronic design & algorithm development using LabVIEW	There are many possibilities for algorithms relating to autonomous mobility, navigation based on stereo, omni-directional, & thermal imagers, in addition to several tasks relating to image registration, behavioral robotic intelligence, user interfaces for robot guidance & supervision.
LaRC	Spacecraft	Nanomaterials Characterization for Aerospace Applications	Characterization and imaging of carbon nanotube networks in materials using Atomic Force Microscopy
LaRC	Lunar & Planetary Surface Systems	(1) Mid-IR laser based Differential Absorption Lidar (DIAL) development for water vapor detection. (2) Mid-IR laser based DIAL development for ice detection. (3) Frequency Modulated (FM) CW lidar development for CO2 sensing at near-IR	(1) Modeling & simulation of water vapor sensing on Mars & other planetary surfaces; analysis of coherent, direct & hybrid detection based system architectures. (2) Modeling & Simulation of ice detection on Mars & other planetary surfaces using differential absorption schemes. (3) Design & development of FMCW lidar architecture suitable for CO2 profiling of Martian environment from orbiting platforms. (4) Study coherent laser radar techniques (in the wavelength range 1-2 microns) for terrain mapping, instrument landing, & autonomous docking applications for Lunar & Mars surfaces. (5) Experimentally analyze lunar & Martian soil simulants at deep UV wavelengths (in the range 193-210 nm) based on laser-induced fluorescence & Raman spectroscopy.

Center	Area	Title	Description
		wavelengths. (4) Coherent laser radar for 3D imaging of hard targets using near-IR wavelengths. (5) Deep-UV wavelength based chem-bio detection for mineralogical & life signature characterization.	
LaRC	Spacecraft	Resonant Difference-Frequency Atomic Force Ultrasonic Microscopy (RDF-AFUM)	The RDF-AFUM technique employs an ultrasonic wave launched from the bottom of a sample while the cantilever of an atomic force microscope, driven at a frequency differing from the ultrasonic frequency by one of the contact resonance frequencies of the cantilever, engages the sample top surface. The associated signals are used to create images of nanoscale near-surface and subsurface features.
LaRC	Lunar & Planetary Surface Systems	Assessment of uncertainty quantification and Modern Design of Experiments (MDOE) for impact dynamics applications.	This work is important in the context of the Orion Landing System development application & has potential for the future spacecraft and lunar lander work. A graduate student would be best suited for this particular topic as it integrates two specialized areas - impact dynamics and uncertainty quantification (using probabilistic analysis). Impact dynamics is based on an understanding of the nonlinear, transient-dynamic behavior of structures. The quantification & propagation of a number of uncertainties will require a knowledge of probabilistic analysis. MDOE can be used to minimize or control some uncertainties. The focus of the graduate student's effort will be in the application of probabilistic analysis for uncertainty quantification to an impact dynamics application. In order to most effectively work on the project the graduate student should have knowledge in either nonlinear, transient-dynamic structures or probabilistic analysis. In addition, experience with finite element modeling & signal processing would be helpful.
DFRC	Spacecraft	Intelligent health monitoring of spacecraft	Develop approaches to self-monitor and diagnose the in-flight health of spacecraft
DFRC	Spacecraft	Adaptive logic and learning systems	Develop approaches for machine-learning and techniques to adapt to changing operating constraints
DFRC	Spacecraft	Distributed data systems and integration	Develop efficient strategies for networking in highly cluttered data-driven environments and methods to integrate distributed data systems
DFRC	Spacecraft	Ad-hoc networking (store and forward) with buffered data management	Develop methods that store and forward critical operational data for rapid assessment of situational awareness
DFRC	Spacecraft	Intelligent power management	Develop efficient approaches for power management of critical on-line assets, systems, and subsystems
DFRC	Spacecraft	Small-scale fuel cell applications	Demonstrate small-scale fuel cell applications for aerial platforms
DFRC	Spacecraft	Dynamic soaring/Autonomous autopilot	Develop aerial platforms that exhibit autonomy and dynamic soaring capabilities

Center	Area	Title	Description
DFRC	Lunar & Planetary Surface Systems	Next Generation Air Transportation systems	Develop simulation approaches to examine operational concepts for the next generation of aerial transportation systems
DFRC	Lunar & Planetary Surface Systems	Sensor-guided flight control avionics	Develop novel approaches to reliable and robust autonomous control
DFRC	Spacecraft	Sensor-guided vehicles	Develop architectures for integrating structural sensors into avionics for robust autonomous control of aerial vehicles
DFRC	Spacecraft	Guidance and control of unconventional vehicles	Use Multidisciplinary Analysis and Optimization (MDO) software to assess the stability of non-conventional aerial platforms
DFRC	Spacecraft	Fiber-optic sensors for dynamic measurements	Develop novel approaches to measure mechanical stresses using tunable fiber-optic sensors
DFRC	Spacecraft	Interoperable intelligent guidance and control architectures for autonomous operations	Develop soft-computing approaches that enable guidance and control of autonomous aerial platforms to perform docking maneuvers, refueling, and a multitude of other self-guided operations
DFRC	Spacecraft	Intelligent data acquisition and on-board data processing	Develop architectures and simulation approaches for real-time data acquisition and processing of in-flight aerodynamic parameters